Anwar Boctor, left, and Wayne Haag spot the green stalk of a resistant plant among many plants killed by late wilt disease.

EGYPT’S MAIZE ARMY

Egypt has pulled together widely dispersed scientists into an efficient, systematic maize research group. With CIMMYT’s help, the foundation is being laid for sharply raising the productivity of the nation’s major food crop.
Extraordinary Egypt: abundant water, rich soil, cloudless skies combine to give some of the world’s highest crop yields. But farm land is so scarce. Every hectare produces food and fiber for 17 persons, supplies feed for four farm animals, and provides most of Egypt’s foreign exchange earnings.

In the next 25 years as Egypt’s population relentlessly swells from 39 millions to 70 millions, the already high productivity of the land will have to double or triple if Egypt is to shake free from the grasp of centuries of poverty and malnutrition.

Much of the burden in the sober race with population falls on scientists and technicians who work with Egypt’s largest food crop — maize. See box: ‘Cereals in Egypt’s economy.’ Yields of maize jumped 25 percent when, in 1965, irrigation water first flowed from the Aswan High Dam permitting early planting. Since then the yield trend has levelled off. Now, however, there are signs that new maize varieties, a vigorous national maize program that is unified in spirit, if not on paper, and better understanding of the farmer’s field will rapidly push maize productivity higher. CIMMYT, through a staff member stationed in Egypt, through visits of its Mexico-based scientists, and through its international maize testing, has been helping Egypt.

CIMMYT is able to provide a maize advisor to Egypt through a grant from the Ford Foundation. CIMMYT also covers the costs of most Egyptians who participate in the CIMMYT in-service training course in Mexico. The Ford Foundation additionally supports Egyptian maize research with vehicles, laboratory equipment, and books. The U.S. Department of Agriculture contributes funds for research on opaque-2 maize and late wilt disease.

Wayne Haag, CIMMYT’s man in Egypt, is a U.S. — born, Arabic-speaking, plant breeder trained at Michigan State University and Pennsylvania State University. He has worked with farmers in Costa Rica, India, and Guatemala, and was a post-doctoral fellow with the CIMMYT maize program in Mexico.

CIMMYT is in Egypt because Egypt asked for help in strengthening its maize research and production. (See box: ‘Early work of CIMMYT in Egypt’). ‘A favorable political climate exists for change, and the desire on the part of the various people to have a successful program is very good,’ Haag said recently. ‘On a broader scale, the government has plans to increase the output of nitrogen fertilizer considerably over what it is now, meaning more fertilizer will become available for maize. The government also plans to tile-drain over 400,000 hectares of poorly drained soils. Maize which is very sensitive to excess soil moisture and salinity should benefit from this.’

The long-term goal, according to Haag, is to make maize production as efficient as possible in terms of time and area. Currently, Haag says, ‘we are setting up the pipeline — population improvement, uniform station trials, on-farm trials, links with seed multiplication and extension people.’ The effectiveness of a foreign advisor like Haag depends on whether he can win the confidence of his colleagues. He has to be able to convince each scientist that he has something to offer technically in order to get their interest. He is in no position to dictate, he can simply make suggestions and participate in the day-to-day work. S.M. Dessouky, director of Egypt’s field crop research, praises Haag’s influence: ‘Haag gave us a new spirit. He is one of the group. He sees the picture and the problems.’

In addition to working with maize researchers, Haag, as a resident outsider, is available on short notice to add weight to proposals of the maize program that are being considered in government councils. Similarly, when Egyptian maize researchers approach international agencies for funds for machinery, buildings, etc. Haag is able to act as a knowledgeable, impartial go-between.
Egypt's agricultural areas

Egypt has about as much cultivable land as Denmark—and eight times the population. Egypt's 2.3 million arable hectares represent less than 3 percent of the nation's area. Three-fifths of the farm land is in the Nile delta. The rest lies in a ribbon, 2 to 10 kilometers wide, running a thousand kilometers up the Nile Valley from Cairo to the Aswan Dam near the Sudan border. All the land is irrigated.

Aside from patches of fruit trees or sugarcane, every field grows at least two crops a year. In the winter, 3 out of 5 hectares are covered with beerseem clover, a legume valuable as a livestock feed and as a means of fixing nitrogen in the soil. Wheat occupies most of the remaining land during the winter.

In summer, cotton is grown throughout the nation but nearly all farmers have land in a cereal crop, too. In the delta, near the Mediterranean coast, rice is the dominant summer cereal. For the saline soils there, rice is far more profitable than maize which is sensitive to salts. Moreover the concentration of rice fields makes it easier to regulate canal flows to provide the large amounts of water rice needs.

Overall, cotton and maize each occupy about a third of the land during summer, rice covers about 20 percent, and sorghum, 10 percent.

Egypt has a beneficent climate for agriculture. Sun shines every day. Minimum temperatures in the winter season (October to April) are 5 to 10 degrees centigrade, while in the summer maximum temperatures range from a balmy 20 degrees in the delta to a searing 40 degrees near Aswan. Rainfall ranges from insignificant to nil, but, of course, the Nile is there (See box: 'The life-giving Nile').

A network of irrigation canals 26,000 kilometers long carries water to every field. The water is free, but rationed. Government authorities allow water to flow in the canals of a district for a week and then close the canal gates the next week. Despite this alternating wet and dry schedule and regulations governing the size of outlet to each farm, farmers tend to over-irrigate.

The completion of the Aswan High Dam unfortunately set off an alarming decline in the productivity of Egyptian soils. The reason is not, as might be thought, that the dam ended the Nile flood and with it the annual deposit of silt. Rather, the year-round irrigation and lack of field drainage has lifted the water table. Minerals rise in the water-filled soil capillaries and concentrate near the surface, making the soil saline. H.A. El Tobgy, former undersecretary of agriculture, estimates that 25 percent of the delta is affected by salinity and subsoil compaction related to perennial irrigation. Half of Egypt's cultivated lands have been reclassified downward to medium or poor because of irrigation without good drainage.

Since 1965, Egypt has reclaimed about 10,000 hectares a year (while losing 5000 hectares a year to urbanization). Some of this reclaimed land is 'new land' in the desert west of the Nile Valley which can be irrigated with water from the Aswan dam, but a substantial part is formerly productive land in the delta. The World Bank is currently supporting the installation of tile drains in about a fifth of Egypt's cultivated land.

El Tobgy believes that soil salinity has muted the impact of Egypt's efforts to improve varieties, to increase fertilizer use, to extend farmer credit and so forth. He estimates that good field drainage could boost Egypt's yields 20 to 30 percent.
Fertilizer

Fertilizer is heavily used. Egyptian farmers annually apply an average of 140 kilograms of nitrogen per hectare and 25 kilograms of phosphate to their fields. These high rates explain in part why Egypt has among the world's highest national nitrogen per hectare and 25 kilograms of phosphate to their district. They sometimes buy additional fertilizer.

Egypt is self-sufficient in production of phosphorus fertilizer and produces about half its nitrogen fertilizer needs. It may be self-sufficient in nitrogen fertilizer by 1980.

With population rapidly growing and with cities saturated with excess labor from rural areas, Egypt has no other choice than to make its precious land more productive by taking greater advantage of its sunshine, water, and year-round growing season. The ultimate test of the success of maize improvement in Egypt cannot be increases in yield per hectare or production per season, rather it must be gain in yield per hectare per day. Higher efficiency in production of maize should give the farmer more land or time (a longer season) to devote to other crops. Thus improvement in the efficiency of one crop, such as maize, has ramifications for output of other crops.

Egypt's maize varieties

Farmers in Egypt first planted maize about two centuries ago. The ancestors of Egyptian local varieties probably arrived in Spain from the New World, traveled south to Morocco, and from there trickled across North Africa until they reached the Nile. Because a vast desert separates Egypt from the tropical African countries where maize found receptive soil and because maize is not merchandize traders wish to carry great distances, additional varieties rarely entered Egypt. Consequently the genetic base of Egyptian 'local' varieties has remained narrow.

In the 1920's, plant scientists in Egypt selected the ears from the best plants of a variety from the southern USA. This selection was called American Early Dent. It was, in fact, later maturing than local varieties, but its higher yielding ability attracted some Egyptian farmers.

After World War II, hybrids were released. Most of these resulted from making inbred lines from local varieties and crossing them with inbreds from American Early Dent and other inbreds introduced from the USA. American Early Dent was found to combine well so it was used in producing a wide array of hybrids.

Today, Egyptian farmers still plant 80 percent of the land to local varieties. The rest of the maize land is in American Early Dent, double-cross hybrids (produced by crossing four inbred lines), variety-cross hybrids, and newly released composites.

Generally, farmers' varieties mature earlier than American Early Dent, variety crosses, and composites, and are shorter so they have less tendency to lodge, or fall over, near harvest. The double-cross hybrids are more like farmers' varieties in maturity and height but they are vulnerable to late wilt, a maize disease.

Diseases and insects

Late wilt, caused by a fungus, and the complex of insects called stem borers are the chief enemies of maize in Egypt.

Late wilt (Cephalasporium maydis) is important only in Egypt although it occurs in India and Pakistan, too. The fungus attacks the plant tissues which carry nutrients. The leaves wilt and the kernels do not become well filled.

Late wilt was first noticed in Egypt in 1954, but not until 1962 was disease agent known. Alternating rice and maize as the summer cereals helps control late wilt. Because of their susceptibility to late wilt, Egyptian double-cross hybrid maizes are restricted to limited areas that use this uncommon rotation.

Breeding is the best weapon for controlling late wilt. One benefit of testing tropical American maize varieties in Egypt was the discovery that Tuxpeño, a Mexican variety, has excellent resistance to late wilt. Unfortunately the nature of the disease makes breeding for resistance a slow process. The symptoms of late wilt do not appear until after the time for pollination has passed. So plants identified as resistant cannot be crossed until the following crop.

Stem borers have become less threatening to maize production since 1965. Before then, a fourth of the maize crop was planted early—in May and June—and the rest was planted at the time of the Nile flood—July, August, September. Since the population of the European maize borer (Ostrinia nubilalis) builds up in the late summer, the young plants of the late seedings are always ravaged.

When the Aswan dam began functioning, permitting irrigation at any time, large numbers of farmers, prodded by a massive government extension campaign, began planting maize earlier. By the 1970's farmers planted nearly 80 percent of the crop in May and June. The result was an astounding lesson in the power of change in farming practices to combat a biological enemy. Early planted maize escapes damage from the European borer. As a consequence, the average maize yield in Egypt rose from 2800 kg/ha in 1964 to 3600 kg/ha in 1966. In addition, the area sprayed against stem borers dropped from 235,000 hectares to 25,000 hectares.
While stem borers do less damage than formerly, they still take a toll on the maize crop. Egyptian scientists are breeding for resistance to the pink sugarcane borer which attacks early planted maize, as well as to the European borer.

Assembling the maize army

Egypt has a body of trained maize scientists that many other countries would envy, but as A.L. Fawzi, head of the Maize Research Section, says, 'getting all maize people to work in the same channel is a critical bottleneck in raising the productivity of farmers' fields.' The Maize Research Section itself contains only breeders and agronomists. Other specialists such as entomologists and pathologists are scattered through other agencies of the Ministry of Agriculture.

Although the organization chart hasn't changed, Egyptian maize workers, with encouragement from CIMMYT have taken steps to begin functioning as an Egyptian national maize program, or, as it is nicknamed, 'the maize army.' Wayne Haag says, 'For me the most important thing is to get people involved.' Over a period of
3 months in 1975, maize workers met to discuss what they wanted. They succeeded in establishing one research program emphasizing solution of on-farm yield problems and they established research priorities. The idea that agencies have to work together became more widely accepted. Previously, for example, the Maize Research Section did not frequently visit farmers' fields because that was the domain of other agencies.

Haag believes that it is important that all participants see themselves as part of the same team with the same goals. To get them to work together, he says, they must have a good relationship and there must be something physical to cooperate on in research projects. If many people feel they have contributed to producing a new variety, for example, they will smooth the way to getting it tested and out to farmers. ‘Any variety produced must have lots of hands in it,’ says Haag.

Today, the maize army is composed of 60 workers from the Maize Research Section, the Pathology Section, the Entomology Section, the Field Verification Section, the Cereal Technology Section, and the Agricultural Economics Institute. The Maize Research Section acts as coordinator and unifier of the other groups.

Maize scientists are now also conducting meeting and field trips with extension workers, staffs of credit banks, and cooperatives to discuss maize research and to show what progress is being made. Seed multiplication personnel regularly visit trials with maize researchers to see the performance and growth characteristics of experimental maize that they may soon have to multiply.

The Maize Research Section itself has undergone reorganization. In 1976 a breeding unit, an agronomy unit, and a foundation seed production unit were created, each with its own chairman. The chairmen and the director and subdirector of the Maize Research Section now set the overall program plans.

A third of the scientists who make up the Egyptian maize army have been in Mexico for the 6-month-long in-service training program at CIMMYT headquarters. On their return to Egypt many of the trainees have acted as trainers for their colleagues.

Plant breeding

Egypt is putting more emphasis on open-pollinated maize varieties. S.M. Dessouky explains, ‘We were depending on double crosses. The procedures needed are difficult. CIMMYT encouraged us to look at other methods that are easier and which allow farmers to use his own seed. This is one of the good things we got from CIMMYT.’ Farmers have not clamored for the double-cross and variety-cross hybrids because of the late-wilt susceptibility of the former and the tall height and late maturity of the latter. But if superior germ plasm became available, Egypt wouldn’t have the manpower or facilities to produce and distribute hybrid maize seed for the whole country each year. An open-pollinated variety ‘breeds true’ so it is far easier to multiply, and farmers can plant seed saved from their last harvest.

Nevertheless CIMMYT supports the continued production of hybrids in Egypt. ‘If the country is producing hybrids,’ says Haag, ‘my job is to help them produce them as well as possible.’ While visiting a hybrid seed production field in Egypt recently, Ernie Sprague head of CIMMYT’s Maize Program suggested substituting the Mexican variety Tuxpéñito for La Posta as a parent in the Egyptian hybrid VC69. Tuxpéñito, he pointed out, A farmer says good-bye to scientists who have visited trials in his fields.
CEREALS IN EGYPT'S ECONOMY

Maize and rice are Egypt's largest cereal crops. About 2.5 million metric tons of each crop are harvested annually. Wheat production is about 2 million tons a year and sorghum production is about half that.

Egypt's cereal output is inadequate to feed the country. Each year Egypt imports about as much wheat as it produces. Small amounts of maize are also imported, mainly for animal feed. On the other hand, Egypt has exported as much as a quarter of its rice crop to earn foreign exchange.

Until the 1970's the imports of wheat and maize were more than paid for by exports of rice and cotton. In recent years, however, the trends in output and trade in the crops have turned ominous. Between 1970 and 1975, maize production rose only 8 percent, while imports climbed nearly 600 percent to over 400,000 tons or equivalent to one sixth of annual production. Wheat output advanced by a third, but imports rose 300 percent. In 1975, imports made up nearly 60 percent of the domestic wheat supply.

In contrast, output of export crops has fallen: rice by 6 percent and cotton by 30 percent. As a consequence of smaller harvests and rising population, the exports of these crops have shrunk dramatically. Rice exports in 1975 were 15 percent of their 1970 volume, Cotton exports were down by a third from 1970.

The outlook is grave. The U.S. Department of Agriculture estimates that Egypt is currently importing a quarter of its food needs, but by 1985 it will be importing half.

The urgency of producing rapid gains in agricultural productivity is obvious.

out, has much the same germ plasm as La Posta, but it is about a half meter shorter. The shorter the plant, the easier it is for laborers to detassel thoroughly, thus reducing the chances of self-pollination, one source of 'contamination of hybrid seed.

During 1975 and 1976 Egypt reorganized much of its maize breeding into a population improvement program along the lines followed by CIMMYT. The aim is to provide a steady flow of better varieties to farmers. The primary breeding goals are resistance to late wilt, shorter plants, earlier maturity, resistance to stem borers, better quality protein, and, of course, higher yield.

Shorter plants and earlier maturity are especially critical objectives. The environment of Egypt seems to stretch maize plants. Varieties that, for example, grow an acceptable 230 centimeters tall in Poza Rica, Mexico, usually reach 300 centimeters in Egypt. Potentially, reducing plant height offers a proportional increase in yield per hectare. That is, if the height of a maize variety is reduced by a third, its potential yield per hectare increases by a third because one-third more plants can be sown in each hectare.

Egypt lacks a good early maize variety. Ernie Sprague believes that Egyptian varieties could be selected to mature 10 days earlier without sacrificing yield, and that even a reduction of 3 weeks would cut yield by only 10 percent. The advantages of earlier maturing varieties would be less water use, shortened exposure to diseases and insects, and the opportunity for farmers to squeeze in a short-season winter vegetable crop following wheat or clover and before planting maize.

To reorganize its breeding program, Egyptian scientists carefully evaluated their maize populations and chose the six most promising for intensive selection: Composite 108, Giza 1, Shedwan 3, Sids 1, Gemiza 2, and AEDX Tuxpeño opaque. Together these populations are called the ad-
vanced unit. Each population consists of about 500 families and each is tested annually in replicated trials at several locations for yield, maturity, plant height, and disease and insect resistance. Based on these trials, the best performing families in a population are intercrossed, forming an experimental variety every year, and forming new families to be tested the next year. The experimental varieties from each population then enter a series of trials to determine if any merit release to farmers.

Behind the advanced unit is the build-up unit which provides a flow of new genes to the advanced populations. The build-up unit is classified into local germ plasm pool, temperate germ plasm pool, tropical pool, temperate x tropical pool, elite pool (materials with special characters such as multiple ears), and early maturing pool.

Within each pool, families are intercrossed, tested, selected or rejected. If some families perform well, some of their seed will be planted with the advanced population whose characteristics they match. Thus the advanced populations get a regular supplement of new genes, permitting new combinations of genes to occur.

New pools and additions to the build-up unit come from the germ plasm bank. The bank contains local varieties and commercial varieties introduced from abroad. The varieties are observed as they are grown and as seed is increased. The entire bank is being screened to find sources of resistance to European stem borers, pink stem borers, and late wilt. Scientists are also trying to spot early maturing types. When they find varieties that have one or another of the desired characteristics they might form a new pool that could be used for population improvement.

Egypt gets a large additional amount of germ plasm from CIMMYT. Two of the six locations in the world which test the CIMMYT-distributed International Progeny Testing Trial 44 (American Early Dent x Tuxpeno) are in Egypt. Egyptian maize scientists grow IPTT 44 alongside their own advanced populations and decide which families of IPTT 44 should form experimental varieties. Although the choices are made in Egypt, the actual crossing and production of seed of the experimental varieties are done by CIMMYT in Mexico. The experimental varieties selected by Egypt, and by other national maize programs, are sent back to Egypt (and other countries) where they are tested as an experimental variety trial. Through this system Egypt discovered that certain experimental varieties selected in Pakistan, Mexico, and Nicaragua from the IPTT performed well in Egypt. These experimental varieties will be further tested in several research stations in Egypt along with Egyptian experimental varieties selected from the IPTT, and Egyptian experimental varieties selected from Egyptian advanced populations. The best varieties will go into farm trials and from there possibly into seed multiplication for release to farmers, or they will be used in crosses with the best local varieties.

Through this process a new set of experimental varieties is available for testing each year. The ones that perform best can be multiplied and possibly released to farmers.

As a sidelight, just as CIMMYT's distribution of trials gives Egypt access to superior selections made by breeders in other countries, the breeders in other countries benefit by selections made in Egypt. For example an opaque-2 experimental variety selected at the Sids, Egypt, experiment station from the 1975 IPTT was, in 1976, among the five best-yielding opaque-2 varieties at locations in Panama, Jamaica, India, and Mexico.

Improving protein quality
Egyptian efforts to improve the quality of maize protein for human nutrition began in 1975 when two sources of the opaque-2 gene arrived from CIMMYT (CIMMYT’s protein improvement work is financed by the United Nations Development Programme). The protein in the kernels of maizes

On a visit to Egypt, Ernie Sprague, left, head of CIMMYT's maize program, talks about the need for shorter varieties.
The drooping ear of a plant attacked by late wilt disease. The kernels of the ear will not fill completely.

that carry the opaque-2 gene have a higher level of two amino acids, lysine and tryptophan, than normal maizes. Raising the level of these two amino acids improves the overall balance of amino acids in relation to the needs of the human body and allows it to convert a larger proportion of maize protein into body protein.

Egyptian scientists have crossed the opaque donors with local varieties and, by growing two crops a year, they are making rapid progress in selecting high-quality protein maizes with both hard and soft endosperm from segregating materials. Experimental opaque-2 varieties are nearly ready for yield testing.

The cereal technology section’s protein laboratory plays an essential role in developing high-quality protein maize. ‘The laboratory is linked directly to the rest of the maize improvement program,’ observes A.L. Fawzi, ‘so that improvement of protein quality and agronomic characters should be possible simultaneously.’ The laboratory has the capacity to analyze all the high-quality protein maize the breeders produce.

CIMMYT helped Egypt start the laboratory by providing equipment with funds from the UNDP grant. CIMMYT’s protein laboratory in Mexico has also provided 6 months of training to the head of the Egyptian laboratory.

To begin testing acceptance of opaque-2 maize, the researchers plan to give opaque-2 grain to the national nutrition institute for institutional feeding trials.

Accelerated breeding

Egypt’s winters are too cool for a second maize-growing season. Since testing and screening data usually are accumulated too late to be used to guide breeding within the same crop season, Egyptian researchers might be restricted to taking data in one year and breeding in the next. Instead, they have set up an ingenious staggered planting schedule which allows them to gather data and make crosses based on that data in the same year. Yield nurseries and nurseries for rating resistance to pink stem borer and late wilt are planted early in the year. By May, damage from pink stem borer can be rated and, by mid-September, damage from late wilt can be measured and the yield nursery can be harvested. The recombination (crossing) nursery is planted in August so that it flowers in mid-October. At flowering time, the data on yield and on resistance to pink stem borer and late wilt are available to guide breeders in deciding which families to cross with which. The recombination nursery is then harvested in January.

At present, damage from European maize borer cannot be rated until October or November, too late for use in same year’s recombination nursery. But entomologists are relating early season counts of numbers of European maize borers that are feeding on leaves to later ratings of resistance. If leaf feeding is a reliable indicator, then crossing for resistance to the European borer could be done in the same year, too.

Trials

A carefully reasoned series of trials leads from the breeders’ plots to farmer’s fields. The number of varieties being tested becomes narrower as the information about their performance broadens.

Basically there are two types of trials: crop improvement trials and performance trials. Crop improvement trials are aimed at providing information to guide breeders in making crosses and selections to upgrade populations. Data from these trials also help scientists decide which families should be composited into experimental varieties and tested for possible release. Because all experiment stations work on the same populations, all scientists have an equal stake in the success of the varieties that are generated from the populations. The crop improvement trials consist of yield trials at three stations, disease-resistance trials at one station, and insect-
resistance trials at two stations. Breeders, pathologists, entomologists, and cereal technologists work together to evaluate these trials.

Performance trials permit a large number of experimental varieties to be compared with each other and with commercial varieties at many locations and under different farming practices. These trials begin on experiment stations and lead to farmers’ fields.

The, so-called, I-2 trials are the start of performance testing. In these trials, about 40 experimental varieties are grown at six experimental stations in replicated plots. The next year, the best performers are tested again in I-1 trials. CIMMYT experimental varieties are grown separately from the I-2 trials but any that look good go into the I-1 trials in the following year. The I-1 trials are also replicated and grown at all six stations. Simultaneously all varieties in the I-1 trials are each planted in half hectare seed-increase plots. This procedure ensures that when a variety is tested sufficiently to be released, a substantial amount of foundation seed can be promptly passed to the seed production unit. Varieties that perform well in both I-2 and I-1 trials move to on-farm testing.

A limited number of experimental varieties are tested in on-station trials of cultural practices. The I-1 trial simply compares the performance of varieties planted at different dates. The I-2 trial compares several varieties grown at different plant densities and with several levels of fertilizer application. The I-3 trial compares several varieties with different amounts of fertilizer and different times of application. These trials are conducted at all six locations and are replicated.

On-farm testing of maize varieties and practices began on a large scale only in 1975. In 1976, on-farm variety trials were conducted at 26 locations in 10 provinces. The I-I trials consist of a dozen experimental varieties that survived the I-1 trials, a few commercial varieties, and, at each location, the preferred local variety. These trials are unreplicated and all work is performed by the cooperating farmer under the supervision of a local agent of the Field Verification Section. This trial allows farmers— and scientists— to see how new varieties measure up against the local variety under local conditions. Seed of the varieties in III-1 trials is again multiplied.

To provide farmers with good recommendations as new varieties are released, two types of

**EARLY WORK OF CIMMYT IN EGYPT**

CIMMYT participation in maize improvement in Egypt began in 1969, when N.L. Dahwan, an Indian plant breeder, was assigned to work with the Egyptian program. Dahwan was instrumental in giving the exceptionally narrow germ plasm of Egypt a transfusion of new genes. By bringing in maize from CIMMYT in Mexico and from Africa, Dahwan and Egyptian breeders expanded the spectrum of genes available in Egypt. They intercrossed these maize and local ones, bringing together new combinations of genes, which expressed themselves under Egyptian agroclimatic conditions. And they made crosses to find ones that demonstrated strong hybrid vigor.

Aside from vastly increasing the diversity of Egyptian maize germ plasm, the arrival of maize from abroad led directly to several new varieties in 1972. Shedwan 3 resulted from a cross of American Early Dent and Antigua 2 with Kitale II. It is an open-pollinated variety. Shedwan 3 has intermediate resistance to late wilt.

Two variety-cross hybrids were also released in 1972. A variety cross is simply a hybrid created by crossing two varieties. Seed of the variety-cross hybrids is far easier to multiply than seed of double-cross hybrids which involve inbred lines. VC80 (AED x Tepalocingo 5) and VC69 (AED x La Posta) are Egypt’s highest yielding commercial varieties, and they have more resistance to late wilt than local varieties. The drawbacks of the variety cross hybrids are that, reflecting their parents, they are taller and later than local varieties. Height increases the tendency of the plants to lodge (topple over) which makes harvesting more arduous and can cause rotten ears if the ears touch the soil.

Thus, by the mid-seventies, three types of non-traditional maize were available to farmers: open-pollinated varieties, variety-cross hybrids, and double-cross hybrids.

The improved maize all have higher yield potentials than the local varieties. But only the double-cross hybrids are almost as early maturing and as short as the local varieties. On the other hand the double crosses are more susceptible to late wilt than the locals while the newer open-pollinated varieties and variety-cross hybrids are more resistant than the locals.

During the period of Dahwan’s stay in Egypt, 1969-1974 efforts were also made to increase the uniformity and quality of on-station maize field experiments, to provide needed vehicles and equipment, and to expand the knowledge and experience of maize research workers.
A technician in the cereal technology laboratory checks a micro-Kjeldahl apparatus. The laboratory's tests for protein content and quality are essential in breeding opaque-2 maize.

Agronomy trials are being conducted in farmers' fields. The III-2 trials compare varieties and several levels of nitrogen application. The III-3 trials compare varieties under several plant densities.

Periodically through the season, the on-farm trials are visited by small groups of researchers usually including an agronomist, a breeder, an entomologist, a pathologist, a seed production specialist, and the local verification agent. 'The on-farm variety trials give us much more extensive information on the performance of our best materials than we can obtain on our experiment stations,' says Haag.

The visits help the scientists decide which, if any, of the varieties in the III-1 trials merit release to farmers. They allow researchers from several disciplines to observe farming practices and to see how new varieties perform under different agronomic conditions. They allow entomologists and pathologists to monitor the pervasive- ness of maize diseases and insects throughout the country. And they allow seed production person-
nel to become familiar with new maize varieties before they are charged with multiplying them.

In the short time that this system has existed no variety has passed through all the stages and been released to farmers. One of the most promising candidates is Sids 7444, an experimental variety selected from IPTT 44, which has the desired plant height and good yield. In 1976 it was in the I-1 trial and seed was increased. In 1977 it is in the III-1 trial and seed is being increased again. If Sids 7444 performs well in the III-1 trial it may be released to farmers in 1978.

Seed production
The Achilles' heel of many crop improvement programs is seed production. The time and
money spent to create better varieties is worthless if farmers can't get the seed. In recent years Egyptian maize researchers have taken steps to make existing seed production more efficient and to guarantee that when new varieties are released, seed will be quickly available to all farmers who want it.

Egypt's seed production unit has 2400 hectares of seed multiplication fields which annually produce enough seed to plant 15 to 20 percent of the nation's maize land. Until now the amount of seed produced has been more than enough to satisfy farmer demand. Only a small proportion of farmers wish to buy seed of the currently available composites, variety-cross hybrids, and double-cross hybrids because of their shortcomings in late wilt resistance, their long maturities, and excessive height.

As the new open-pollinated varieties are released, the job of multiplication will be easier because detasselling, a tedious and painstaking part of hybrid seed production, is unnecessary to multiply an open-pollinated variety. By joining researchers in frequent field trips, visits to experiment stations, and meetings, seed production people keep well informed of the status of development of new varieties. Moreover they become familiar with the strengths, weaknesses, and idiosyncrasies of the new varieties. With this information the seed production unit can plan the use of its land and laborers so that they can act fast when a new variety is released and must be multiplied.

Setting the direction of future research
In 1976 and 1977, agricultural economists led by Ahmed Goueli of Zagazig University are surveying farmers maize production practices. The need to identify barriers to higher maize yields has been widely recognized. Don Winkelmann, head of CIMMYT's economics program, encouraged Egyptian agricultural economists and maize researchers to draft a questionnaire jointly. The economists contribute knowledge of survey technique and analysis, the biologists contribute knowledge of the maize plant and agronomic practices. Through this collaboration the questionnaire asks questions that will yield data and analysis that maize researchers can use to set priorities for their future research. Winkelmann also helped refine the questionnaire and arranged to finance vehicles and per diem for the survey takers.

Specifically the questionnaire is aimed at identifying barriers to greater 'maize productivity per unit of area and time and/or the intensification of competing crops.' It asks farmers about such

THE LIFE-GIVING NILE

In 1863 a barrage placed across the Nile began lifting water into irrigation canals. For the first time it became possible to plant large areas of summer crops such as maize, rice, sugarcane, and, especially, cotton, which became the mainstay of the economy.

The first dam at Aswan was completed in 1902. To increase the amount of water stored behind the dam, its height was raised several times before work began on the Aswan High Dam in 1960. The completion of the High Dam in 1965 ended the annual Nile flood and the age-old basin irrigation. From that point, all of Egypt's cultivated land could be irrigated throughout the year.

Before the High Dam, the flooding of the Nile from about August to October marked the beginning of the agricultural year. According to H.A. El Tobgy in 'Contemporary Egyptian Agriculture,' farmers used the flood water 'by diverting it into large basins to a depth of over 2 meters, after which the surplus water was drained back into the river, and the soil allowed to dry enough for tillage and planting... crops could only be grown once a year... their water requirements during the growing season were met by water stored in the deep, soil during the flooded period.'

Haroon El Shafey, one of the many members of the maize army who have taken the CIMMYT in-service training course.
topics as attitudes toward new varieties, planting densities, degree of leaf stripping, importance of plant height, and fertilizer use.

The survey was conducted among 160 farmers in 40 villages in the Nile delta in 1976. In 1977 the survey is covering the maize-growing region south of Cairo.

Preliminary data on leaf stripping from the survey provides an example of the value of this work. The farmer's practice of stripping leaves to feed cattle is commonly believed to reduce maize yields. Previously, however, scientists could only speculate on how many farmers practice leaf stripping, how thoroughly they strip the plants, and in what part of the growing season stripping is done.

The 1976 survey in the Nile delta indicated that 75 percent of the farmers strip leaves from their maize fields one to three times during the season. Nearly half the farmers strip leaves for the first time after the maize is mature; almost no farmers strip leaves before flowering. Most farmers strip only three to five leaves from each plant — about half the leaves below the ear.

These findings suggest that leaf stripping may not affect yields greatly: on the average few leaves are taken and, more important, leaf stripping usually takes place late in the season. By understanding how the farmer strips leaves, researchers will be able to simulate farmers' practices to measure how much they reduce yields. In addition researchers have a better idea of what practices they must improve upon. As Wayne Haag says, 'To simply advise the farmer not to strip the leaves from the maize plant is not enough. Better alternatives must be found which will meet his forage needs.' By marshalling the skills of economists, breeders, pathologists, entomologists, and others the maize army is mounting a sweeping attack on restraints to high maize productivity. That augers well for maize farmers along the Nile. —Steven A. Breth.
An Egyptian farmer.