PN-AAT-251

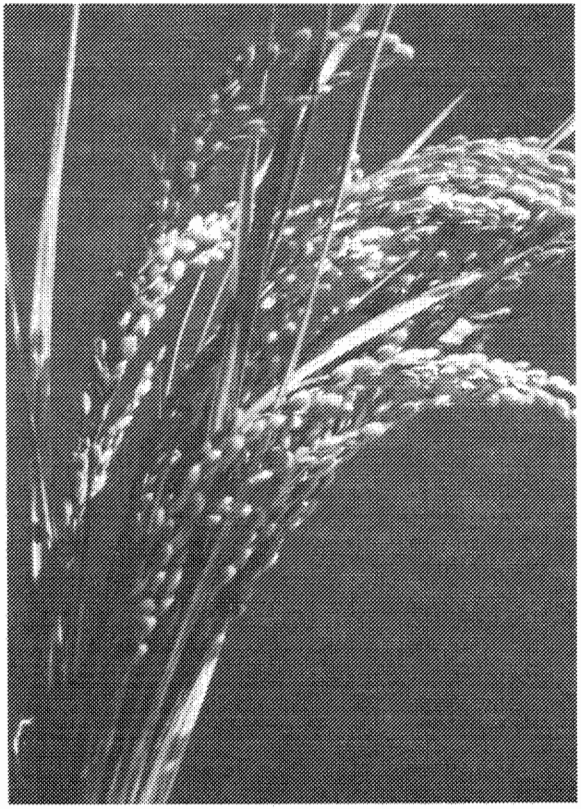
A NEW ERA FOR RICE IN EGYPT

A COLLABORATIVE PROJECT

RICE RESEARCH AND TRAINING PROJECT

A collaborative project of the Ministry of Agriculture-Egypt, the University of California, Davis, the University of Arkansas and The International Rice Research Institute. Financed by the United States Agency for International Development and by the Government of Egypt.

PANICLES OF SHORT GRAIN RICE—This grain type together with medium grains dominate Egypt's rice production.



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A NEW ERA FOR RICE IN EGYPT

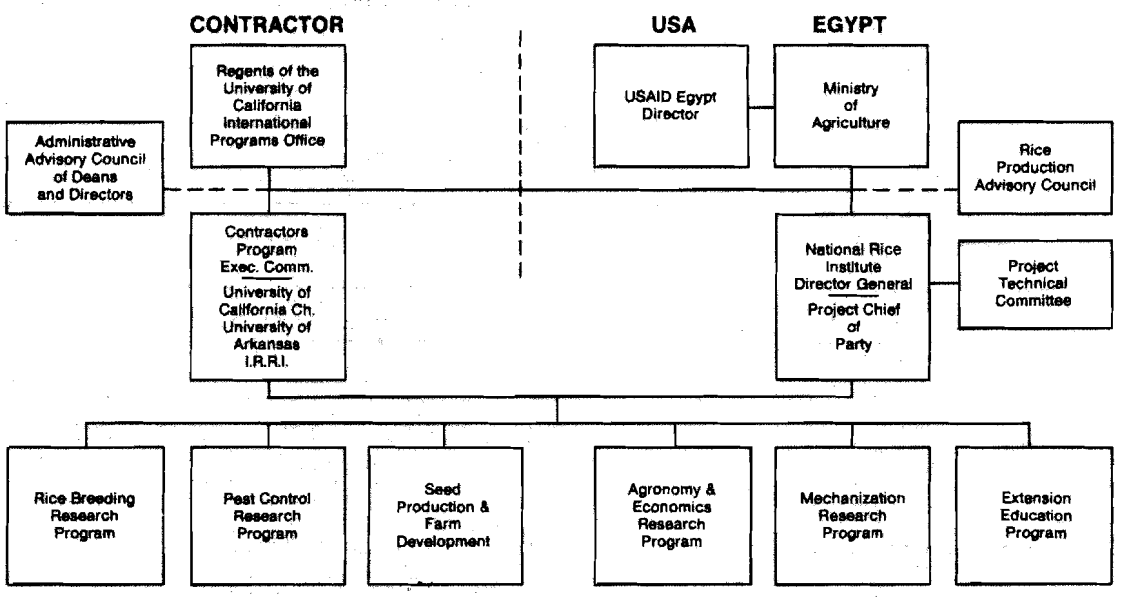
The Rice Research and Training Project is a five-year, international effort to modernize one of Egypt's historic agricultural and economic assets—its rice-producing capacity. The goal is to fit contemporary science and technology to Egypt's rich natural resources, and to the skills and needs of a million or more Egyptian rice farmers. And, by 1990, to boost the nation's output of rice by at least 25 percent.

Launched in 1980, the Rice Project is jointly financed by the Egyptian Government and the U.S. Agency for International Development (USAID). Its research and training programs are carried on by a multi-national team of scientists from:

- The Egyptian Ministry of Agriculture
- The University of California (prime contractor)
- The University of Arkansas and The International Rice Research Institute (sub-contractors)

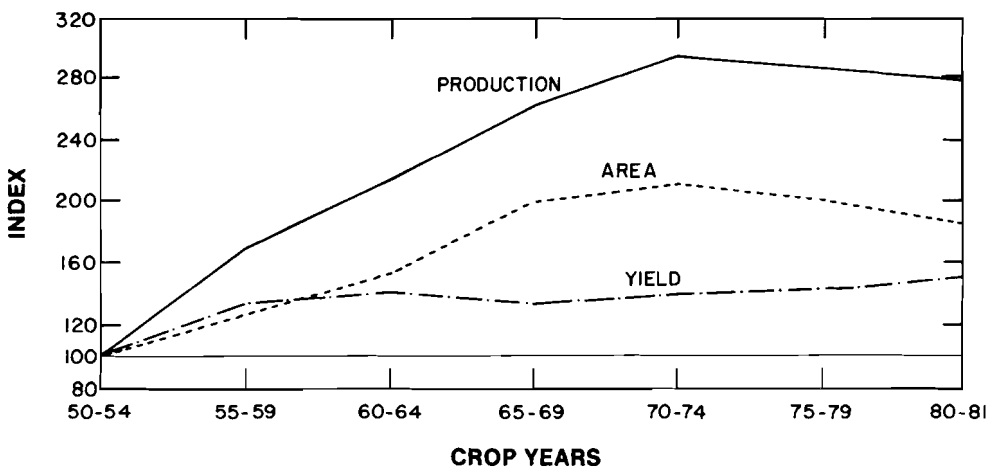
The Rice Project is administered jointly by the Ministry of Agriculture and the University of California, Davis, as the lead institution. USAID is charged with administering international development assistance funds for the United States Government.

ORGANIZATIONAL STRUCTURE
RICE RESEARCH AND TRAINING PROJECT



The Project's work in improving rice varieties, production inputs, farming methods and integrated pest control; in adapting the use of labor saving machines to Egyptian rice-growing conditions; and in setting up a system to create and pass on new technical information has developed out of the context of Egypt's resources and recent history. Here are some background facts:

- In Egypt, rice is grown on about 1 million "feddans" of land (1 feddan = 1.03 acres), usually in sequence with other crops such as wheat, maize, cotton or forage (berseem clover). Rice planting doubled after the Aswan High Dam was finished in 1965, but since the early 1970s actual output has gone up only slightly. Hence the Egyptian government's concern, since rice is a crucial commodity for the nation, both nutritionally and economically.
- Little additional land suitable for rice is available in Egypt. The nation's plans to produce substantially more rice depend primarily on increasing the yield from each existing feddan and on reducing losses during and after harvest. Hence the Rice Project's emphasis on technology and more intensive farming methods.
- Climate, water and soil in Egypt generally satisfy all of the needs of the rice plant. In fact, the nation's rice yields already are high compared to many other rice-growing areas.
- While Egypt's rice harvest has increased very little for a decade or more, its need for food has almost doubled. The population of 44 million, with a density among the highest anywhere, is expected to double again by the year 2000.



AVERAGE PADDY RICE AREA, YIELD AND PRODUCTION, EGYPT, 1950-1981

1950-54 index base (100) represents 218,000 hectares, 3.802 MT/hectare yield and 830,000 MT production.
Sources: El-Tobgy, H.A., Contemporary Egyptian Agriculture, 2nd Ed., 1976, and ERS, U.S.D.A./ARE-MOA data.

The Challenge for Science

This is the problem faced by the Rice Research and Training Project: to start Egypt on the road to self-sufficiency in this basic food crop, formerly a major export and now sometimes in short supply even for Egyptians.

Clearly, there is potential for a much larger rice harvest in Egypt. "A 25 percent increase by 1990 is a reasonable and attainable goal," says one scientist-administrator. "That would be a national average of about three metric tons per feddan. Actually, world record yields of five tons per feddan could be attained in Egypt. Biologically, there's no reason why not."

Biological potential is one thing, but it is quite another to improve actual farming systems, especially centuries-old systems like those of Egyptian agriculture. Rice Project scientists must create packages of new technology (improved varieties, seed, planting methods, cultural practices, etc.) which not only fit the small-scale methods of the typical Egyptian rice grower but make a profit for him as well. Fortunately, many of the Project's recommended farming methods both increase rice yield and reduce costs—thus providing a double pay-off.

For examples:

- A new rice variety being released to growers in 1983 requires 15 days' less time to mature. This gives farmers an additional two weeks to use the land for another crop, thus enabling them often to realize another cutting of valuable berseem clover. The new rice variety also resists pests and diseases and has higher yield potential.
- With labor costs mounting, the task of transplanting rice seedlings by hand is consuming more of the farmer's profits. Project researchers have demonstrated how to sow seeds directly into the field at flooding, a practice adopted by many farmers in 1982. Rice Project workers also are adapting and demonstrating small machines to (1) transplant seedlings into flooded fields or (2) drill seed into the dry soil before flooding. Any of these mechanical methods—if managed correctly and used in combination with the right varieties, fertilizers, water management and pest controls—will increase yields and cut costs.

In developing breakthroughs like these, Rice Project scientists work in various subject matter areas:

- *plant breeding,* to create and screen new rice varieties,
- *seed increase and certification,* to put pure seed of the new varieties into farmers' hands,
- *agronomy,* including plant nutrition, water management and cultural methods,
- *plant protection* against weeds, disease, insects and other pests,
- *mechanization,* seeking small-scale implements that can be locally manufactured and maintained,
- and *economics,* keeping in mind that successful new technologies usually cut costs.

The Challenge of Information Transfer: The Mabrouk 4 Program

"Mabrouk" means, roughly, "That's great!" The phrase congratulates a farmer for harvesting four tons of rice per feddan. This is a high yield, but achievable with the new varieties and methods.

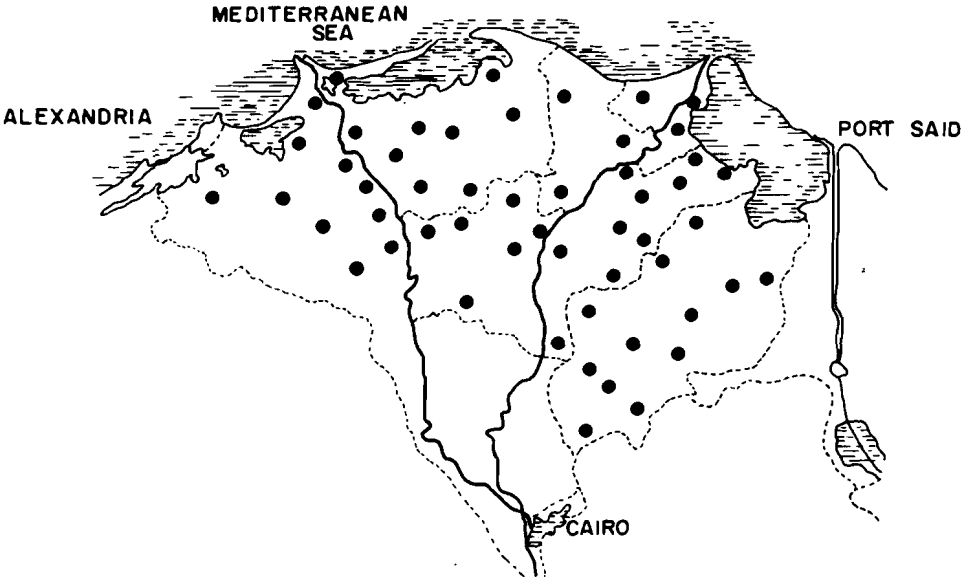
Scientific research, even adaptive research that seeks answers in field station plots and farmers' fields, is not enough. After the fact-finding, two more steps are required:

- Carrying information to the only people who can put it to use—the farmers.
- Building institutions that will continue the research and training process into the future, when more challenges and more changes are inevitable.

The first step—extending information from laboratories and test plantings to the field—is symbolized by a now-famous slogan originated in the Rice Project: Mabrouk 4!

Within the Rice Project, information moves outward through an extension network of technical specialists, regional rice production advisers and district rice production trainers. (A district contains 20 or 30 villages.) This same communication system passes information about the farmers' problems back to the researchers.

At the village level, research findings and recommendations go to Ministry of Agriculture extension workers and to officials of local agricultural cooperatives. Also, demonstration plots are grown in the fields of leading local farmers.



SITES OF MABROUK 4 FIELD DEMONSTRATIONS IN 1982

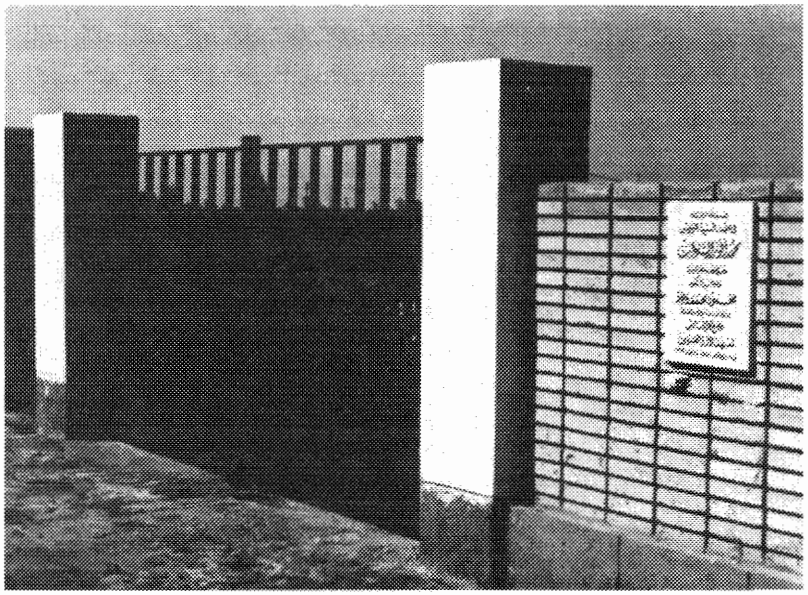
In 1982, rice growers who took part in the Mabrouk 4 programs averaged almost two-thirds more yield than non-participating farmers, a fact confirmed by both random sampling and comparing total yields of the two groups.

That gain can be credited to specific, research-based recommendations, including:

- Use of certified seed of the new, short-season, short-stature varieties.
- Use of inexpensive herbicides to control weeds.
- Deep placement of fertilizer to improve its use by plants.
- Use of substantially less seed for nursery plantings. (That's right, fewer plants. Seedlings not crowded in the nursery are more vigorous, and 3 to 5 can be transplanted per hill rather than the traditional 15 or 20.)

TRAINING SEMINAR — Discussions are held on a weekly basis to acquaint researchers with developments in rice research and extension.

BUILDING SITE of National Rice Institute at Sakha, Kafr El-Sheikh, was dedicated in 1982.



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A Look to the Future

In 1983, at the mid-point of the Rice Project, a major goal is to prepare for the day when expatriate scientists from the University of California, University of Arkansas and The International Rice Research Institute (IRRI) will leave, and their Egyptian colleagues will continue their work in a permanent rice research and training organization—a center for rice research within the Ministry of Agriculture.

Toward this goal, steps already have been taken:

- At the Sakha station, a site has been set aside for the National Rice Institute, and contracts have been let for laboratories, greenhouses and other facilities.

- Laboratory and field equipment has been provided to enable more in-depth research.

- Egyptian rice researchers are receiving advanced scientific training at home and abroad. In 1982, a total of 17 were working toward advanced degrees in Egyptian universities, and six were abroad at the Universities of California and Arkansas and at IRRI in the Philippines.

In 1985, the five-year international cooperative Rice Research and Training Project will end. At that time, plans are for Egypt's on-going central rice research program to concentrate on:

- Continued improvement of varieties, crop production and pest control practices.
- Mechanization, fitting new technology to small landholdings and cropping patterns of the nation's agriculture.
- Production of certified seed of new improved rice varieties.
- An on-going flow of information to rice farmers, explaining and demonstrating new methods and new technologies for increased economic yields and improved rice quality.

And, it is hoped, the stage will be set for Egypt to become self-sufficient in rice production and to provide for increased export.

Program Achievements

Since its start in 1980, the Rice Research and Training Project has worked in a number of program areas—plant breeding, seed production and certification, agronomy (soils, water, and cultural practices), plant protection, mechanization, economics and extension of information. During that time, expatriate scientists and their Egyptian counterparts have worked to improve the structure and operations of the rice research and extension program. Procedures have been developed to:

- identify specific goals of each program area,
- develop programs of work (projects) to achieve each goal,
- improve reporting and dissemination of research results, and
- coordinate research and extension activities.

An important new development has been the use of trained extension specialists in rice production as a link between researchers and the village level, where research findings are put to use. One of their most important tools is demonstration plantings scattered throughout the rice-growing areas.

Here, briefly summarized, are progress highlights of the various program areas.

PLANT BREEDING

Today 95 percent of Egypt's rice acreage is planted with two long-season, tall-growing varieties (Giza 171 and 172), and the remainder with special varieties that are salt tolerant (Giza 159) or that produce long grains (Giza 180).

For several years, Rice Project plant breeders have been working toward varieties that have: (1) short stature, which do not fall over ("lodge") as they mature, (2) earlier maturity, thus saving water and allowing more growing time for other crops, (3) salinity tolerance, (4) even better resistance to diseases and insect pests, and (5) higher yield potential.

In 1983, the breeders announced:

- Giza 173 (formerly "Reiho," adapted from a Japanese rice variety), which is expected to completely replace Giza 172 by 1984. It matures 15 days earlier, grows about 20 centimeters shorter, and yields an average of 10 percent more. It also resists blast, the most serious plant disease of rice in Egypt, and stem borer, the most serious insect pest.

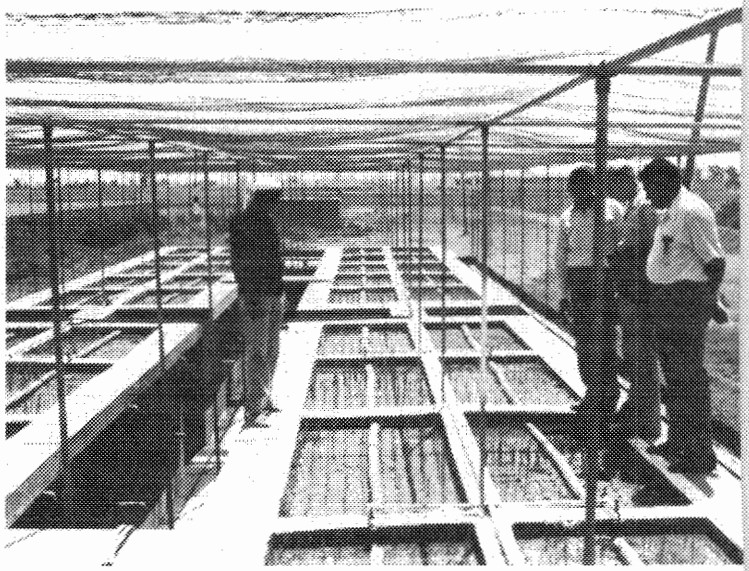
- Giza 181 (formerly IRRI 1626), a long-grain variety with better yield and better grain quality. It will replace Giza 180 in 1985.

- Two other short-stature, short-season varieties, one of which will replace Giza 171 in 1985. It will be named Giza 174.

- Two candidate salt-tolerant varieties, one of which will replace Giza 159 in 1985, to be named Giza 160.

IMPROVED SHORT-STATURED VARIETIES— These feature resistance to lodging, pest and salt tolerance, yield and quality improvements.

RICE HYBRIDIZATION—An ongoing technique for improving the adaptability of rice for Egyptian conditions.



SALT-TOLERANT RICE— Experimental strains of rice are grown in saline water to identify those that are resistant to salt damage.

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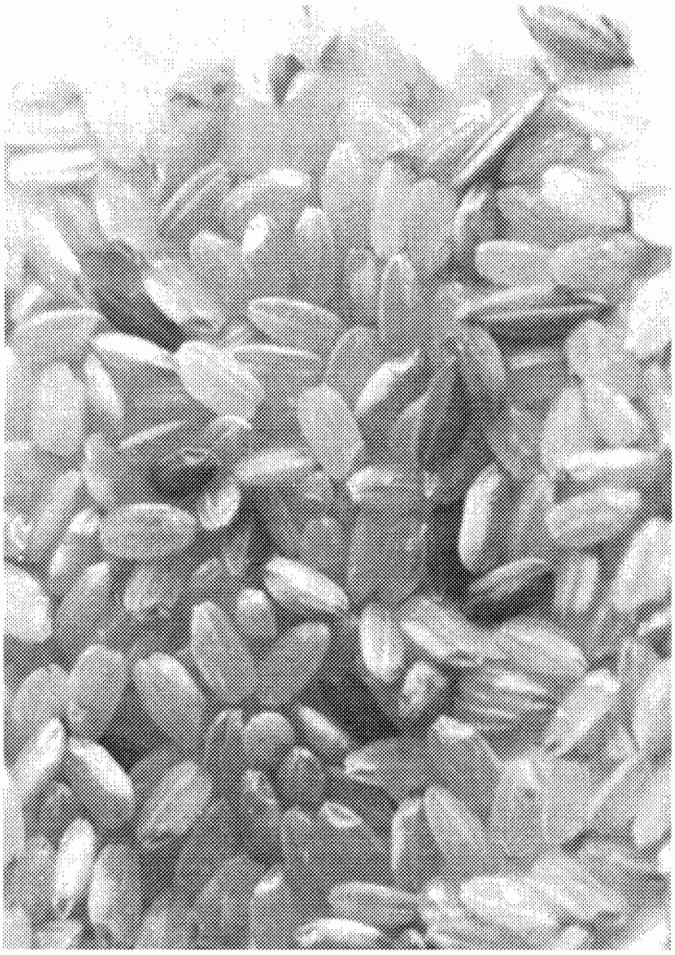

QUALITY PROBLEM — Grains of "red rice" are visible in this close-up view. Elimination of red rice in planting seed is a national objective.

SEED PRODUCTION AND CERTIFICATION

At the start of the Rice Project, a survey showed two important problems in Egyptian rice seed production:

- A shortage of genetically pure seed.
- Rice seed carrying "red rice," an off-type with a dark red coating on the grain. This coating is difficult to remove during milling, and a shipment contaminated with "red rice" gets a low grade and a low price.

Rice Project seed specialists set up a co-operative program with the Egyptian Seed Production Board to:

- Grow the first three generations of pure seed from each new variety (breeder's seed, foundation seed, registered seed). In 1982, a total of 3,200 feddans of registered seed was grown. Not a single sample was rejected by the inspectors.
- Work with local extension and Seed Production Board personnel to supervise production of the fourth generation (certified seed), which is then provided to growers. About 20,000 feddans of certified seed were grown under the extension program, and two-thirds of the yield passed inspection. (Not a bad record, considering that this was the first year of certified seed production for many of these growers.) An even larger acreage was grown under the Seed Production Board program.

In two years, the Rice Project seed program has produced enough certified seed of existing varieties to plant half of Egypt's rice acreage — in addition to increasing the seed of new experimental varieties. Also, red rice contamination has been reduced, with the Project's emphasis on quality.

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RATOON CROP—At left, rice stubble is starting to grow again after cutting. This practice, called "ratooning," as well as other cropping systems and sequences, are being investigated by Rice Project researchers.

AGRONOMY

A generation ago, Egyptian farmers increased their rice yields by changing from the practice of sowing directly in the field to growing seedlings in a nursery, then transplanting them by hand. Today, the trend is reversed. With labor costs soaring and with new economical weed control methods available, where good water management is possible it is more profitable for many rice growers to seed directly. Others, however, might be better off simply by making the transplanting process more efficient.

With these trends and problems in mind, Rice Project agronomists are testing and adapting two systems with cultural variations:

- transplanting, either by hand or by small mechanical transplanters.
- direct seeding, either broadcast directly into water or by mechanical drill.

The choice of planting system, the agronomists and economists say, should be made according to three criteria: potential profit, availability of technology and farm management capabilities. All the methods produce equal yields if—and this is a big "if"—they are accompanied by good cultural practices, good soil fertility and water management, and good weed control.

Other findings and recommendations of the agronomy program:

- Inexpensive zinc fertilizer used on a rice seedling nursery frequently increases the final grain yield as much as one-third of a ton per feddan. Not all Egyptian rice soils are zinc-deficient, but many are.
- Placing nitrogen fertilizer below the surface of dry soil before flooding can save a significant amount of the nitrogen, which otherwise would turn to gas and be lost. This is an example of accepted technology confirmed under Egyptian conditions.
- Rice seedlings should be transplanted at no more than 30 to 35 days of age. If they are held longer in the nursery, a common practice, the older plants grow poorly when transplanted and yield drops.
- To use sunlight efficiently, shade out weeds and maximize yield, seedlings should be planted no farther apart than 20 by 20 centimeters.
- Lower-than-customary seeding rates in nurseries result in stronger plants and better yields, both in the nursery and in the field. This finding alone could save Egyptian farmers 20,000 to 40,000 tons of planting seed each year.
- Effective cultural methods have been developed for Giza 173 (Reiho) and other new improved short-statured and short-duration varieties. These include date of planting; rate and method of planting; use of fertilizer; and irrigation management. The possibilities of ratooning for double cropping as well as crop rotations suitable for these short-season varieties are receiving special attention.

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WHITE HEADS—Stem borer damage to the rice plant results in dead heart and white head symptoms.

DISEASE, INSECT PEST AND WEED CONTROL

As in all rice growing areas of the world, Egypt's farmers face continual threats—and, sometimes, substantial crop losses—from plant disease, insects, birds and rats, and especially from weeds.

Plant Disease Control. Egyptian farmers are fortunate that only two or three serious plant diseases of rice are established in their country. However, one of these—blast, a fungus disease—is potentially very damaging. At present, nationwide yield losses to blast are fairly low because of resistance bred into the Giza varieties; but there are many races of the fungus, and new ones that could overcome the resistance are a constant threat.

To keep abreast of the danger, Rice Project plant pathologists:

- Survey and sample fields in all six rice-growing governorates of Egypt, looking for new races of the blast pathogen and any other plant diseases that might appear.
- Work with plant breeders in developing disease resistance in new varieties. From this activity came proof that the new Giza 173 (Reiho) variety resists virtually all races of the blast fungus.
- Test fungicides, which at present cannot be used economically, but are needed for backup in case of severe disease outbreak.

Insect Pest Control. The most bothersome insect problem for Egyptian rice growers is the rice stem borer, which today causes an estimated 3 to 5 percent loss to the nation's rice crop. In general, the Giza varieties are moderately resistant to stem borer as well as blast disease.

Besides helping to develop resistant varieties—generally the best way to deal with both plant diseases and insect pests—Rice Project entomologists have:

- Shown that the stem borer can go through four generations in a single season under Egypt's conditions, if it gets a head start in early-planted rice. Later plantings reduce the danger by cutting the number of generations, but later plantings also reduce yields.
- Demonstrated that insecticide treatment, gamma-BHC, should be timed to hit the third generation of stem borers. This is generally about 45 days after transplanting.
- Developed controls for other rice insect pests: mole crickets and bloodworms in the nurseries, and occasional infestations of cutworms in fields where rice follows berseem clover.

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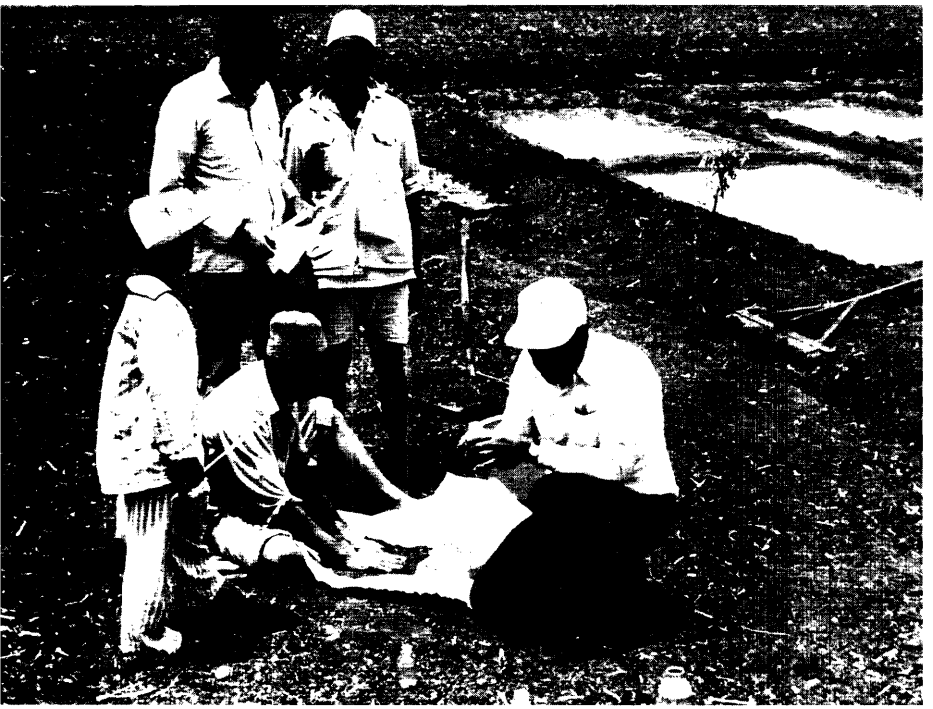
Weed Control. Building on previous pest control programs of the Egyptian Ministry of Agriculture, weed control research by the Rice Project is aimed at integrating new technologies, such as herbicides, with traditional methods. Two trends make the need urgent: (1) the increasing shortage of labor for hand weeding and (2) the move toward direct seeding rather than transplanting, which increases the weed threat.



WEED KILLER—A Mabrouk 4 demonstration shows how to mix herbicide with soil for safe and effective application by hand.

Rice Project researchers have worked out a way for small farmers who do not have mechanical equipment to apply a relatively safe herbicide, thiobencarb, to control all three major weed pests of rice, namely, sedge, barnyard grass and redstem. The farmer simply mixes a measured amount of herbicide with dry soil and applies the mixture as specified on the herbicide label. This creates a thin, weed-killing layer at the soil surface.

Weed control researchers also are:

- Developing ways to apply herbicide after transplanting. This is needed because mechanical transplanting disturbs the protective layer of herbicide-treated soil, giving weeds a chance to grow through.

- Studying weed control with two methods of direct seeding: broadcasting by hand and drilling by machine. Both methods make rice more vulnerable to weed competition. Cultural methods are important here, since precise soil leveling and water management can control many of the weeds.

Rat Damage. Severe damage to rice, in Egypt as in most other rice-growing areas of the world, is caused by rats. Unfortunately, no easy or entirely effective control is available, although traps and poisoned baits can help. One thing is certain: control measures must be taken simultaneously over sizable areas, since rats simply migrate away from small treated spots.

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MECHANIZATION

The key to successful mechanization of Egypt's rice industry is "adaptive technology," which means not emphasizing new inventions but adapting those proved elsewhere to Egyptian conditions and cropping patterns. In the process, there are two basic rules:

- Besides working efficiently, the machines must be small, uncomplicated and inexpensive. Egyptian rice growers do not have much money to spend and cannot afford to take large economic risks.

- The machines must be easy to maintain and repair—and, if possible, manufactured—at the village level.

Engineerng tests in 1982 showed, for example, that one man with a small, hand-powered device can mechanically transplant rice seedlings at the rate of one-half to one feddan per day, cutting hand transplanting time by 60 to 90 percent. A small-scale, engine-driven reaper (capacity: 5 or 6 feddans/day) and an improved small thresher will be tested in 1983. All of these are IRRI designs. The thresher is being manufactured in Egypt under a development program with which the Rice Project is cooperating.

Fortunately, the new machines work best with the new, high-yielding, short-strawed varieties of rice. Other new technologies—use of herbicides, for example—also tie in with both mechanization and the new varieties. From the viewpoint of the farmer and Rice Project trainers, each new method must be coordinated within the total cropping system. For example, the new reapers and threshers must work well with wheat as well as rice, since many farmers grow wheat in winter and rice on the same field in summer. The sooner wheat can be harvested, the sooner rice can be planted.

Priorities for rice mechanization in Egypt include:

- Irrigation. A small, simple pump designed by IRRI shows promise for replacing larger and more expensive pumps and, to some extent, the ancient animal-powered devices for lifting water.

- Harvesting and threshing. A Rice Project survey showed that the hand-sickle cutting process is often a bottleneck during harvest.

- Mechanical transplanting. Time and labor savings are important to allow planting at the optimum time and to obtain maximum yields.

- Land preparation and leveling, especially for direct seeding and placement of fertilizer in dry soil. This work is being done in coordination with the soils and agronomy specialists.

In addition, Rice Project engineers are developing a system of simple attachments to the basic tractor-drawn chisel plow. These will level the seedbed, drill the seed, and place fertilizer at the proper depth. (Few Egyptian farmers own a tractor, but many hire the services of a local tractor operator. The attachments would be available through him.)

Inexpensive, low-lift pump appears promising in Egypt's rice-growing districts.

NEW MECHANIZATION STATEGIES are important in modernizing Egyptian rice production.

Mechanized rice transplanters can replace traditional hand-planting techniques at economic costs.

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ECONOMICS

The Rice Project is examining Egypt's total rice production system in economic terms. Particularly, Project economists are studying problems identified by the extension team: What are the constraints that keep average rice yields in Egypt at about half of their biological potential? How many of these constraints are technical (fertilizer rates, etc.) and how many are institutional (water delivery schedules, credit, marketing, etc.)?

One central fact is the increasing cost—and, at times, actual scarcity—of farm labor. Farm wage rates have doubled during the past three or four years, largely as a result of migration to the cities and to jobs in neighboring countries. This is one reason why more Egyptian farmers are looking for new, more efficient methods and machines.

In a pilot survey of several hundred rice growers during 1982, Rice Project economists compared "Mabrouk 4" farmers—those working with village extension agents and using Project methods—with non-participating farmers. Their preliminary conclusions suggest strongly that the Mabrouk 4 methods save both labor and capital, so far. (As mechanization spreads, capital costs could increase.) Total cash costs appeared to be about one-fourth lower among participating farmers, and yields were at least 12 percent higher.

During 1983, a survey of about 1,000 rice farmers in the major rice-producing governorates will be carried out to establish a data bank of costs and practices in the Egyptian rice industry.

EXTENSION: MABROUK 4

The Rice Project program to transfer information from the scientist to the farmer, described earlier, is the last and essential step. Rice production subject-matter specialists (pest control, soil and water, varieties and seed production, and cultural practices) work with 25 advisors in the six rice-growing governorates and with 50 district trainers. This rice production specialist link between researchers and the village-level extension program is a Rice Project innovation. At the village level, the Mabrouk 4 program works with the Ministry of Agriculture extension agents and with local agricultural leaders and officials.

During 1982, this program included:

- A letter signed by the Minister of Agriculture to each participating rice grower, encouraging him to follow Mabrouk 4 recommendations. This proved to be a powerful motivation.
- A bulletin on rice production aimed at extension workers, directors of cooperatives and educated farmers.
- Orientation and training meetings in the governorate capitals for agricultural officials.
- Meetings in each district for directors of cooperatives and village extension workers.
- About 1,400 meetings at the village level with local extension workers and growers.
- Applied research plots, to adjust the Mabrouk 4 recommendations to local conditions.
- A 20,000-feddan certified seed production program, part of a district-level system of demonstration plantings.
- A system of local demonstration plots. In size, these were 3 to 5 feddans for each village. They were planted early and used as outdoor "classrooms" to teach local rice farmers how to use the new package of technologies.

OUTDOOR CLASSROOM—Mabrouk 4 training sessions for farmers are held where demonstration plantings can be seen at first hand.

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MABROUK 4

Here are the specific points in the Mabrouk 4 package of technology, derived from the applied research trials:

When transplanting

- Prepare the nursery during the first half of May, using 40 kg. of certified seed per feddan.
- Make dry applications of nitrogen to both nursery and main field.
- Apply zinc sulphate to the nursery, 1 kg/kerate (20 kg/feddan), during water leveling.
- Use chemical weed control in both nursery and main field.
- Soak and pre-germinate seeds before sowing.
- Transplant 3-5 plants per hill of 30-day old seedlings at regular spacing (20x20 cm).
- Treat for stem borers, if necessary.

When direct-seeding, follow the same procedures for field preparation (above) but broadcast pre-germinated seed into shallow water (2-3 cm), which is then raised gradually to 5 cm of continuous flood.

When drill-seeding, pre-irrigate to germinate weed seeds; let soil dry and harrow lightly to kill weeds; drill seed. Control weeds with herbicide after planting. Irrigate and quickly drain the field until plants are 4-8 cm tall, when continuous flood is applied.

- Use good water management.
- Drain the field two weeks before harvesting.
- Harvest the rice crop when 85% of the grains on the upper half of the panicle turn yellow (straw color).
- Place the rice bundles in heaps with panicles upwards until completely dry. Thresh and clean harvest carefully.

Final Analysis

HARVEST—Sacks of rice are delivered to a village agricultural cooperative.

What has happened to rice growing in Egypt during the past few years is the first chapter of a potential success story—an account of problems analyzed and progress made toward solving them. The next chapter will be interesting and, it seems likely, also productive. As new technology and new methods continue to reach the growers who utilize Egypt's resources of land, water and sunshine, new problems can be expected to emerge. That is part of the process of resource development. But scientists of the Rice Research and Training Project and of the Government of Egypt are confident that Egypt's rice harvest will accelerate its upward trend.

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T.S. Ismail	*Weed Control*
A.M. Tantawi	*Entomology*
M.M. Parker	*Mechanization*
A.F. El-Azizi and Jack M. Swagerty	*Seed Production*
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C.J. Moss	*Mechanization (8/80 - 12/81)*
V.E. Ross	*Extension (2/81 - 9/82)*

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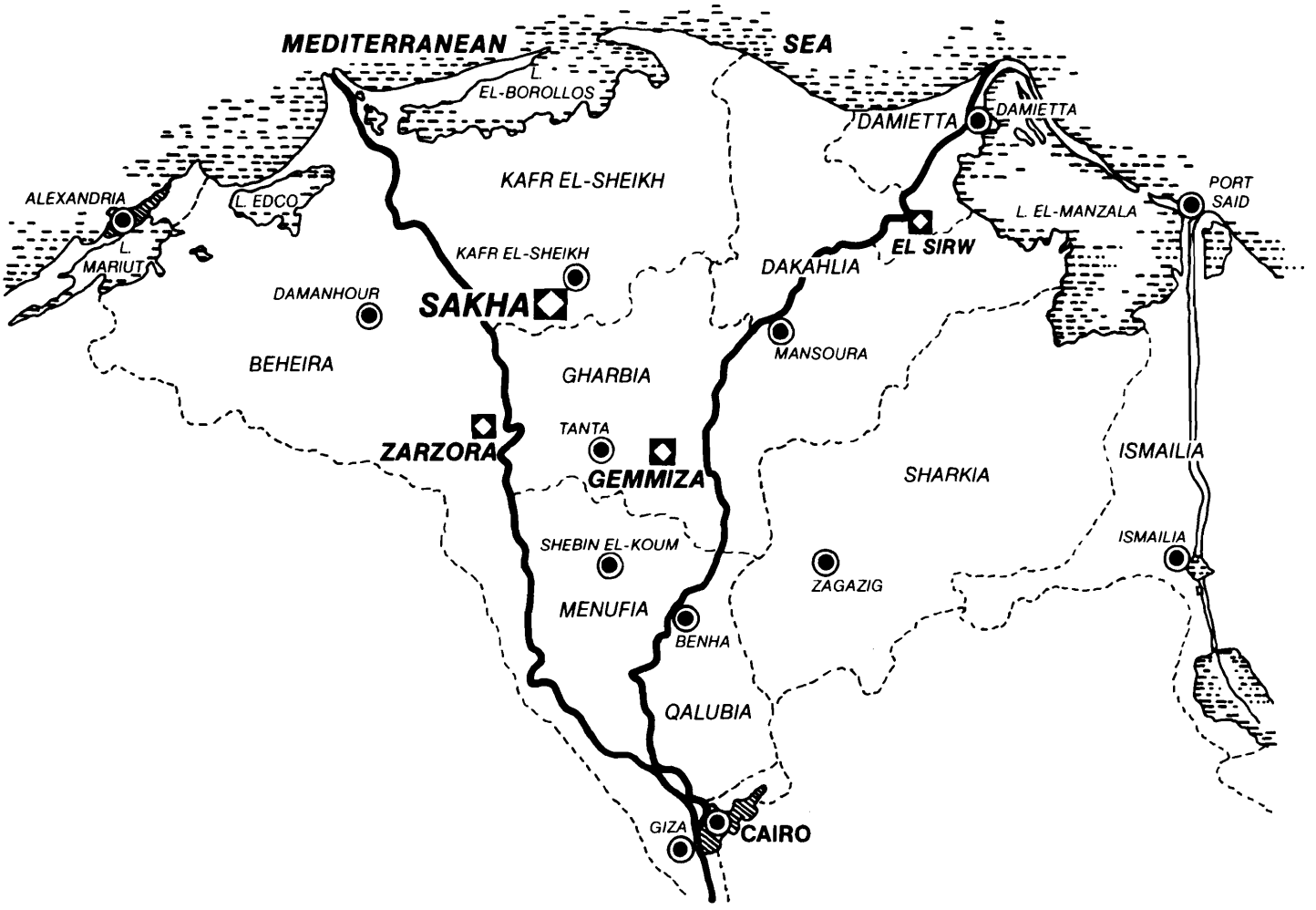

LOCATIONS FOR RICE RESEARCH, NILE DELTA, EGYPT