and a life member of the M.I.T. Corporation, headed a search committee of eight corporation members which also recommended changes in the structure of the presidency. It appears the selection process was democratized somewhat by the involvement of two other committees—a special faculty advisory group and special advisory panel made up of Corporation members, faculty members, and students.

Some observers in the faculty say that the choice of Gray will be welcomed by a conservative constituency in the faculty who feel that administrative policies during the protests were too permissive or who disapprove of Wiesner's political activities. In recent years Wiesner has been outspoken in his criticism of the Vietnam war and has been a leader of the opposition to ABM deployment. Wiesner has also been active in Democratic party matters. It should be noted that, although Gray's political views have a more conservative cast than Wiesner's, he has been deeply involved in administration and policy matters at M.I.T. during the difficult times of recent years and is very closely identified with curriculum experimentation and reform which are prominent issues now at the institute.

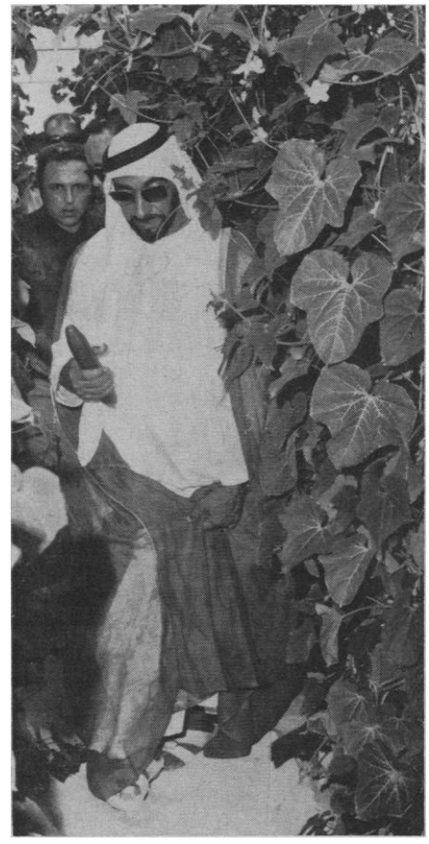
If Wiesner's political stance does not seem to have seriously disturbed the selection committees, his friends say he pondered deeply the implications of becoming a candidate for the presidency. As provost of M.I.T. he could express his views as a private citizen relatively freely. As president he will represent his institution and must necessarily be more circumspect. At a press conference following the announcement of his election, Wiesner said that as president he would no longer involve himself in partisan politics and would take a role in other public issues ony as time permitted, and he didn't expect there would be much time.

M.I.T. is the paramount American technical university. It has very strong intellectual and financial resources, but its new president will face very serious challenges in meeting budgetary problems, modifying M.I.T.'s relationship with the federal government, finding sources of funding for work on health and urban problems, and reforming curriculum and governance. In reflecting on Wiesner's election it seems that it is probably no coincidence that other major private universities, looking for men the times required for their presidents, also chose from within their own communities. At Stanford it was provost Richard Lyman, and at Harvard, law dean Derek Bok, and each, like Wiesner, was a "popular choice" who had proved himself in crisis management.—JOHN WALSH

Arid Land Agriculture: Shaikh up in Arizona Research

Tucson, Ariz. Scientists at the University of Arizona's Environmental Research Laboratory have tapped a novel source of research support funds: Shaikh Zaid Bin Sultan Al-Nahya, ruler of Abu Dhabi. Shaikh Zaid gave the laboratory over $3 million for the construction of a power-, water-, and food-producing facility in his oil-rich desert shaikhdom, south of Kuwait on the Persian Gulf. Construction of the Abu Dhabi facility will give the Arizona scientists a chance to use the experimental techniques they have developed for desert agriculture. And as part of the deal, the Shaikh will continue to pay for a portion of the laboratory's research program.

The relationship between Shaikh Zaid and the University of Arizona began with a 1967 *Time* magazine article describing the Environmental Research Laboratory's research station at Puerto Penasco, Mexico, on the Gulf of California. At the station, the scientists were successfully growing vegetables in the barren coastal desert by using small quantities of desalinated water in controlled-environment greenhouses. When an aide told the Shaikh about the *Time* article (the Shaikh reads neither English nor Arabic), he became so excited at the possibility of having fresh vegetables grown in his country, which has an annual rainfall of 1 inch, that he invited the director of the research station, Carl N. Hodges, to Abu Dhabi. After some negotiations, Shaikh Zaid deposited $1.5 million in a Tucson bank toward construction of a desalinization and vegetable-growing station in Abu Dhabi. Located on a totally barren island known as Jazirat as Sa'diyat (the Isle of Happiness), the station produced its first experimental harvest last year, and full-scale production will begin soon.



Shaikh Zaid Bin Sultan Al-Nahya, ruler of Abu Dhabi, examines one of the first cucumbers grown in his country.

Abu Dhabi occupies a tiny part of the world's 20,000 miles of arid coastline that many people believe could supply large quantities of food if fresh water could be supplied cheaply enough to allow irrigation. In an attempt to develop techniques of inexpensive desalinization of seawater, the staff of the Environmental Research Laboratory began experiments in 1963 at the Puerto Penasco station using solar energy to purify the seawater. Although sunshine could have been used to remove the salt from the water, the scientists at Puerto Penasco eventually realized that a much more easily captured source of energy was being wasted—the diesel engines that were used at the station to pump water and generate power for lights. So

Environmental Research Laboratory's agricultural research station at Puerto Penasco in the Mexican coastal desert. White structures are plastic greenhouses. At right is the desalinization tower.

they simply connected heat exchangers between the exhaust of the engines and the distilling equipment used to purify the water. Their production of water increased, but they had made no advance in desalinization techniques. Thus the Tucson scientists concluded that it would never be economically feasible to purify seawater for open-field irrigation.

Consequently the investigators turned to an examination of various methods of growing plants with minimum amounts of expensive water. The Puerto Penasco facility eventually evolved into a highly integrated system, attempting to make the most efficient use of power and fresh water for food production. On a much larger scale, the Atomic Energy Commission is also working on integrated systems of power, water, and food production at Oak Ridge, Tennessee. Based on a nuclear reactor power source, the AEC's planned developments would be much more massive than anything envisaged by the University of Arizona researchers.

According to Richard Kassander, director of the Environmental Research Laboratory, the types of systems being developed by his group are based on simple diesel engine power sources and therefore might be feasible projects for poor countries that do not have the massive capital required for a nuclear-based facility. Also the agricultural techniques devised by the Arizona scientists could be applied to a nuclear-based desalinization facility or to any situation where only an expensive supply of water is available for irrigation. Kassander told *Science* that the Environmental Research Lab is now planning a facility for crop production in an Indian reservation in a dry area of Northern Arizona.

Open-field irrigation in a dry, hot climate requires tremendous amounts of water for two reasons. First, most of the water in the irrigation ditch simply evaporates before it reaches the plants. Second, a good deal of water escapes from the plants' leaves into the air so that an agricultural plant growing in the desert will consume up to 100 times its weight in water. To control these water losses, the Tucson scientists constructed closed-environment greenhouses, made of plastic and inflated by pumped air.

In the plastic greenhouses, water is supplied directly to the roots of the growing plants through a spaghetti-like network of tubing in precisely the amounts required. Humidity in the greenhouses remains near 100 percent because the air is continually recirculated through a seawater spray. This prevents transpiration of water from the leaves of the plants and serves as a device either to raise or lower the temperature in the greenhouses in order to maintain a constant temperature. Crops are planted directly in the desert sand, and the necessary nutrients are mixed into the irrigating water. To work toward making the power-water-food facility an even more efficient system, the Tucson scientists are experimenting with enhancing the plants' photosynthesis by pumping carbon dioxide exhaust fumes from the diesel engines into the greenhouses.

In spite of the simplicity of the concept, the greenhouse environment has a unique and complex ecology. Several parameters including airflow rate, temperature, and amount of sunlight entering the greenhouse can be varied to affect the agricultural output. While experiments at the Environmental Research Lab's facilities continue to search for the optimum growth conditions for each crop, results to date have been more than satisfactory. Eggplant, squash, lettuce, and more than 30 other crops have been harvested from the closed-environment greenhouses in areas where nothing grows outdoors except cactus and other desert plants. Yields far exceed those obtained from open-field agriculture.

The Tucson scientists estimate that the Abu Dhabi facility will produce over 2 million pounds of fresh vegetables per year from its 5 acres of plastic-covered land. Because of the paraphernalia involved, the costs of this agriculture still exceed the costs of conventional farming techniques. It is hoped that the production costs of the Abu Dhabi vegetables, after the Shaikh's capital investment, can be held at 20 cents per pound. This is more than an acceptable price for vegetables to Abu Dhabians who share in the country's oil revenues and who now must pay $1.50 per pound for vegetables flown in from other countries. But such costs exceed the resources of many poor, dry countries.

Scientists at the Environmental Research Lab are confident that continued research can bring the production costs of the vegetables down. At present their research in arid land agriculture is supported by the Rockefeller Foundation and by Shaikh Zaid. Perhaps foreign aid in reverse could assist other laboratories that are unable to obtain funds from the American government.

—ROBERT J. BAZELL