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The Greening of the Arab East

an update

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The Greening of the Arab East

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With famine threatening large regions of the Third World, Aramco World *reporters returned this year to the farmlands of the Arab East to see what progress has been made by Arab planners and planters since our last survey of the region's food output (See* Aramco World, *May-June 1978). As then, artist Norman MacDonald and contributing editor John Lawton traveled through the Fertile Crescent, the Arabian Peninsula and the Nile Delta — MacDonald sketching and painting on-the-scene impressions, Lawton interviewing farmers and agency officials and compiling the masses of statistics essential to a full grasp of the problems — and progress — of agriculture in the Arab East today.*

Also contributing to this issue were Rami J. Khouri, Aramco World's *correspondent in Jordan, and author of* The Jordan Valley — Life and Society Below Sea Level; *Arthur Clark, a contributing editor in Dhahran, Saudi Arabia; free-lance writers Dr. June Taboroff from Saudi Arabia; Michael Spencer, reporting on dryland farming in Iraq; Terrence Gallacher, covering agriculture in the United Arab Emirates; Pat McDonnell from Syria and Ian Meadows from Cyprus. Together they helped assemble this report on a subject vital to the future of the entire Middle East — the region's drive to increase food self-sufficiency by the greening of the Arab East.*

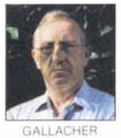

LAWTON


MACDONALD


KHOURI


CLARK


SPENCER


GALLACHER


MCDONNELL


TABOROFF

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Cover: In Egypt, the Colossi of Memnon, standing across the Nile River from modern Luxor, brood over an ancient landscape that is beginning to change as modern agricultural techniques combined with time-tested methods extend cultivation farther from the lush banks of the river and improve the quantity and quality of the crops. Back Cover: An olive farm at Jerash in Jordan, where the greening of the Arab East is already well under way. Illustrations by Norman MacDonald.

◀The Aramco garden center at Dhahran – forerunner of numerous plant nurseries that have sprung up recently to serve Saudi Arabia's Eastern Province.

The Greening of the Arab East

In 1972, a director of the Arid Lands Agricultural Development Program (ALAD), an organization set up by several Middle East governments in conjunction with the Ford Foundation, told *Aramco World* that the "greening" of the Arab East – increased agricultural self-sufficiency – must be achieved within a decade. "The problem," he said, "won't wait any longer."

By "the problem," the ALAD director meant the increased need to import food in many Arab countries – a result of slumping crop yields, soaring populations and what was then called "the revolution of rising expectations." This is another way of saying that as emerging peoples earned more – and learned more – they wanted more, especially in terms of diet.

To find out what has happened since then – during a period when starvation threatened the lives of millions – *Aramco World* this year asked its correspondents for an update on the greening of the Arab East. Their findings are revealing.

First, although famine in many emergent countries is becoming a horrifying possibility, the peoples of the Arab East are today among the better fed peoples of the Third World. According to OXFAM, an organization to combat famine, close to 17 million children under five years of age, will die of starvation in 1983. In addition, the World Bank reports, 450 million people already live on the edge of starvation – and the Food and Agriculture Organization (FAO) says that if present trends continue, "the number of seriously undernourished would reach 600 to 650 million by the year 2000…a horrifying increase."

Second, the Arab East, despite dedicated and sometimes inspired efforts, still faces the need to import too much of its food. Indeed, U.S. Department of Agriculture figures suggest, imports could soar to "a record" $35 billion in 1983.

Import figures, it should be said, are somewhat misleading since the food being imported is different than it was 10 years ago. Like many developing regions, the Arab East has begun to reach for a higher standard of living, and an important aspect of this is a change in dietary preferences – i.e. richer, more varied foods. As a result some undeniably impressive gains in agricultural output seem less than they actually are.

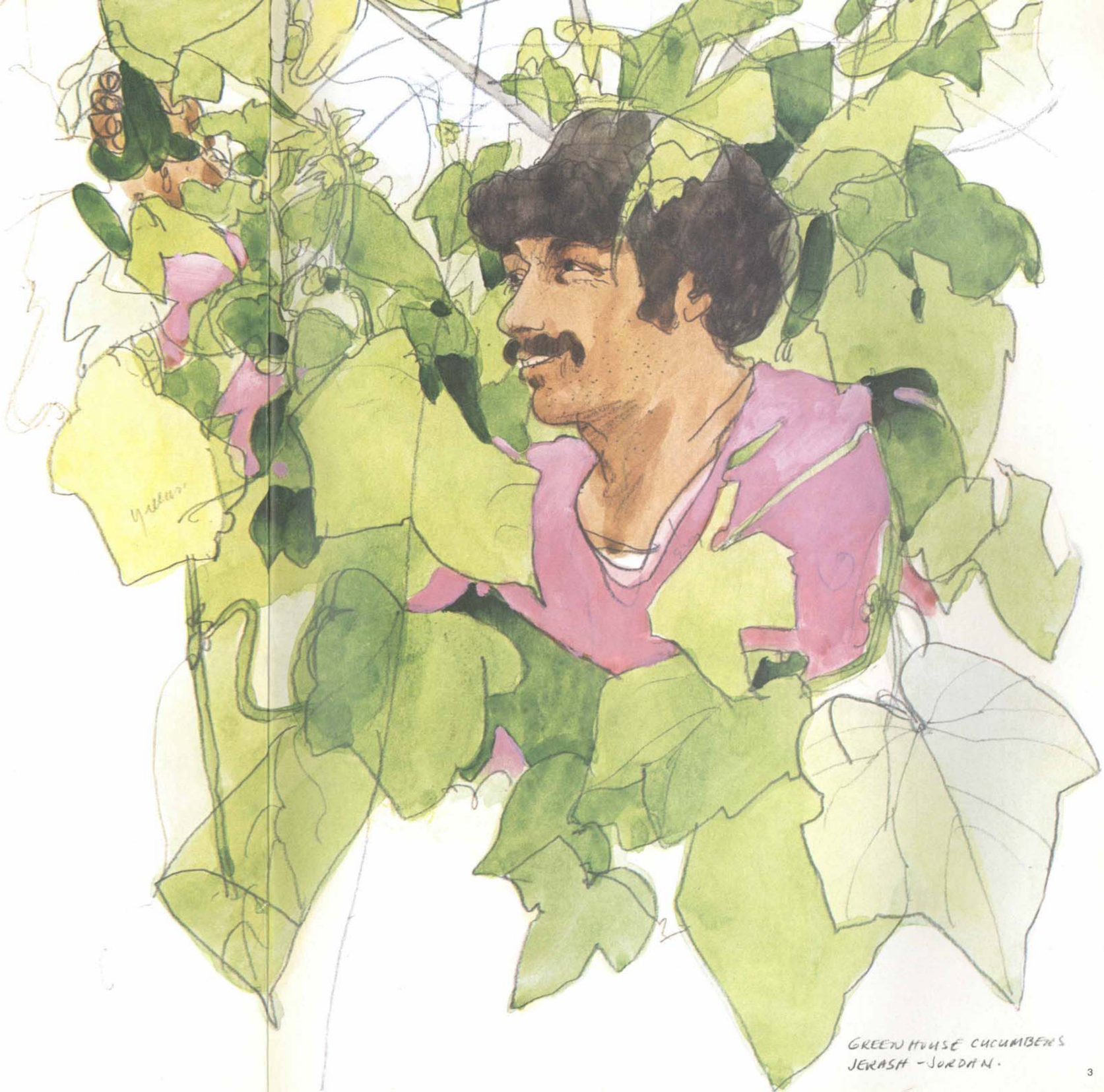
Furthermore, advances in agriculture take time to surface; it can take 10 years of plant breeding, for instance, to develop a dependable new variety of wheat. And from that viewpoint, the pace of progress since Arab governments, collectively and individually, began to work toward self-sufficiency in food, has been encouraging. As early as 1971, for example, as the push for agricultural independence was just getting under way, Lebanon increased its harvest 125 percent simply by planting new wheat strains.

Subsequent improvements have rarely been as dramatic; indeed, there have been losses as well as gains, defeats as well as victories. Some advances, moreover, have cost more money, used more water and fertilizer or taken more time than expected. In Saudi Arabia, for example, wheat farmers grew close to half the kingdom's wheat needs – more than 500,000 tons of wheat in the 1983 season compared to 30,000 tons in 1976. This is a spectacular increase. But the financial cost has been exceptionally high.

On balance, however, the pluses exceed the minuses. Ideas have become experiments, experiments have become projects and the projects, in many cases, have meant progress. Though self-sufficiency is still in the future, it no longer seems impossible and at a time when some regions of the world fear or face starvation, the peoples of the Arab East are now among the better fed peoples of the developing regions – far exceeding, in terms of calories, Africa, Latin America and the Far East.

–The Editors

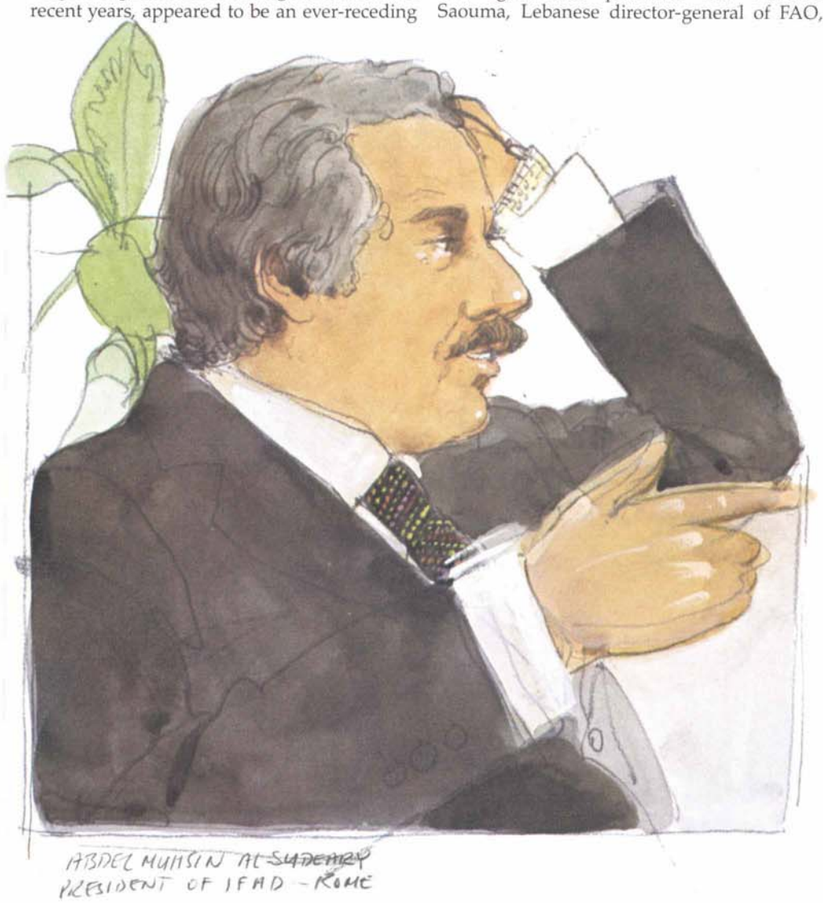
An Introduction



The Planners

Throughout the Arab East this year, there was more than the usual spring-time stir down on the farm. In the oases of Arabia, the valleys of Egypt and Jordan, and on the plains of Syria and Iraq the fields appeared greener and the crops richer. Even the war-weary farmers of Lebanon were back at work. To be sure, the fresh feeling in the air and the new look of the farms were largely due to the season or, in the case of Lebanon, to the end of open warfare. But another vital factor was the gathering momentum of an immense undertaking involving planners and planters in modernizing production processes and introducing new and better crops.

Because the Arab East was by-passed by the first "green revolution" – the 1960's agricultural breakthrough in which such new strains as Mexican dwarf wheat and the IR 8 "miracle rice" helped avert mass starvation in Asia and Latin America – Arab self-sufficiency in food despite huge investments in agriculture has, in recent years, appeared to be an ever-receding goal. Before 1970, the Middle East as a whole was a net exporter of both rice and beans, but must now import both and by 1985, according to the United Nations Food and Agricultural Organization (FAO), the Arab countries' import bill for grains and meat alone will total nearly $5 billion.



The Arabs' growing food deficit is not due to *falling* production, however. In fact, FAO says, the amount of food grown by Near East farmers has *increased* by an average of about two per cent over the last three years. But because of the growing demands and rising expectations of an exploding population – about 3.3 percent per annum – plus a massive influx of foreign workers to staff development projects, more and more imports have been necessary.

Today, there are signs that things are changing. For one thing, planners have proposed or developed new farming and irrigation techniques that enable crops to be grown even in sand. Furthermore their research has produced varieties of traditional staples of the Middle East, such as broad beans, lentils and barley, able to thrive in conditions of drought.

Planners have also adopted new attitudes toward the Arab East's inability to achieve its full agricultural potential. As Edouard Saouma, Lebanese director-general of FAO, put it: "The basic problem affecting food supply results from decisions made by governments and by individuals, not from uncontrollable or irresistible forces of nature. Solutions lie in new policies and new actions."

One new policy is an attempt to increase yields from existing farmlands by improving soil, crop and water management rather than concentrate on massive dams and desert reclamation schemes.
And as what one writer calls the "cultivation revolution" spreads, Arab planners can point with satisfaction to the fact that many of the experiments bringing it about were carried out in their own back yard – mainly by the International Center for Agricultural Research in the Dry Areas (ICARDA) at its experimental station near Aleppo in Syria.

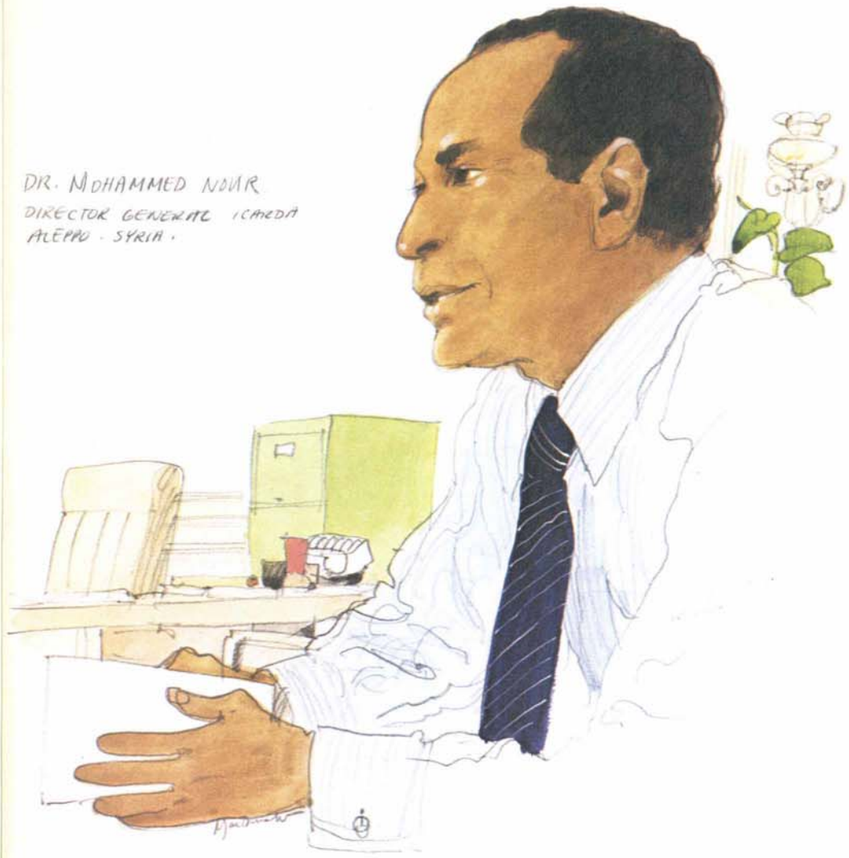
One of the newest links in a world-wide network to improve and increase food production, ICARDA began experiments with the basic crops of the Middle East in 1977 (See *Aramco World*, May-June 1978). Taking over where the Arid Lands Agricultural Development Programs (ALAD) left off, ICARDA's scientists have crossed the most hardy local crop varieties with high-yielding international varieties to produce plants that simultaneously resist disease and drought, tolerate high temperatures and salty soil, and produce a greater abundance of more nutritious food.

"We are not interested," says ICARDA's Sudanese Director-General Dr. Mohammed Nour, "in introducing newer crops such as asparagus or broccoli; rather we are concentrating on increasing the yield of basic food crops per hectare. Jordan, Syria, Iraq and Lebanon once were the granery of Europe. Now they are dependent on Europe for their food, but there is no reason why the area can't once more become the bread-basket of the Middle East."

Already helping to improve the staple diet of millions of people ICARDA-bred plants include five new types of high-yielding, better-tasting cereals that are currently being incorporated in the growing programs of 25 nations; new, more nutritious broad beans in Egypt and The Sudan, and, ICARDA's most sensational breakthrough, a new type of chick-pea, another basic food of the Arab East known most widely for its use in the traditional dish *hummus*.

For millennia, chickpeas could not be sown in the Arab East before the end of February or the beginning of March because if planted during the winter the crop was affected by the *Ascochyta* blight. But now, thanks to disease-resistant genotypes developed by ICARDA, crops planted long before February not only flourish but have a yield fully 100 percent higher than spring-planted crops. Furthermore, since there is more rain before February than after, winter crops can be planted in much drier areas than the spring crops, thereby increasing the area of cultivated land.

Under such programs as the whimsical-sounding acronym FLIP (for Food and Legume Improvement Program), ICARDA has also developed new harvesting techniques for lentils, which reduce labor costs and make cultivation of stony soils economically feasible, and has trained over 250 agricultural scientists from all over the Middle East who are now helping improve their own country's food output.



Meanwhile, at the Kuwait Institute for Scientific Research, marine scientists have refined techniques for breeding shrimp commercially – dramatically increasing the prospect of shrimp farming to replace declining catches in the Arab Gulf due to pollution, over-fishing and destruction of coastal breeding grounds.

Another Arab-inspired force in the greening of the Arab East – as well as elsewhere – is the United Nations International Fund for Agricultural Development (IFAD). Set up in 1977 at the urging of Arab oil producing states, IFAD is unique among international development institutions in that its mandate focuses on the rural poor. In the words of its Saudi Arab President Abdelmuhsin al-Sudeary, IFAD "attacks the development constraints affecting small farmers and the landless." One of the most innovative and effective development institutions in the world, as one publication described it, IFAD is backing 12 agricultural development projects in the Middle East – all, says al-Sudeary, "people-based and poverty-based."

Such small holdings are viewed by planners as vital to the greening of the Arab East. "The small farmer is more successful," explains al-Sudeary, "because their livelihood is at stake – they cannot afford to lose."

Planners, in fact are increasingly looking to the private sector to advance agricultural development. At the initiative of Saudi Arabia, where the public and private sector partnership in farming is already firmly established, the first-ever convention of Arab businessmen and investors agreed in Taif last year, to set up an agricultural holding company to participate with Arab governments in all stages of food production – from land reclamation to marketing.

In addition to such international agencies as ICARDA, IFAD and FAO, numerous Arab agencies are also gearing up to fight the growing food deficit. Among them are the Arab Company for Livestock Development in Damascus, the Arab Union of Fish Producers in Baghdad, the Khartoum-based Arab Sugar Federation, the Company for Arab Agricultural Development, also headquartered in The Sudan, the Arab Federation of Chemical Fertilizers Production in Kuwait and the Arab Union for Food Processing Industries. Also playing a large part will be the Arab Center for Arid Lands Research in Damascus with research stations near Aleppo and elsewhere.

Following approval by Arab governments this spring of an initial $5 billion expenditure, these agencies hope to launch, by the end of the year, the first of over 150 national and multi-national agricultural projects spread throughout 13 Arab states, and expected to cost $33.3 billion, of which about $12 billion is to be spent by 1985 with the rest spread over the next 15 years. Under the aegis of five inter-Arab economic, labor and social organizations – the Council for Arab Economic Unity, the Arab Organization for Agricultural Development and Investment, the Arab Organization for Industrial Development, the Fund for Economic and Social Development and the Arab Labor Organization – these agencies and related federations will play a key role in carrying out this "blueprint" for the future food security of the Arab World.

To some observers, no doubt, these seemingly innumerable agencies may seem excessive. In fact, they are far outnumbered by the problems they have been set up to solve. As Dr. Nour puts it, "The region's needs are urgent; time is short to catch up with the high birth rate."

The number one problem, of course, is aridity; the Arab East includes some of the driest regions on earth. But, FAO reports, other problems too are edging to the fore, including "land degradation" defined as "the partial or total loss of productivity from the land either quantitatively or qualitatively or both, as a result of soil erosion by wind and water, salination, water logging, sedimentation, depletion of plant nutrients, deterioration of soil structure and pollution."

Since the 1970's, land degradation has already wiped out huge areas of cropland in Africa, exposing 100,000 people to starvation. Similar conditions threaten areas of the Arab East too. Dr. Farouk el-Baz, an Egyptian geologist who directed spacecraft photography of the earth's resources (See *Aramco World*, November-December, 1976), says for example that a great sea of sand is moving towards the Nile Delta at about 13 kilometers a year (eight miles), and according to FAO, wind erosion has affected 28.1 per cent of the region's surface area, water erosion 24.3 percent, and salination 5.3 percent. Together, these problems can seriously complicate the already massive challenge facing planners: the need to either increase crop yields from land now under cultivation, or increase the amount of land that can be put under cultivation.

Most of the methods of increasing crop yields, such as controlling the environment in which they grow are relatively new, but one of the most effective methods is almost as old as agriculture itself: fertilizers, the application of additional nutrients to the soil.

Until recently, most fertilizers were derived from natural substances: compost, manure, bones, wood ash, fish, guano and other organic wastes. Today, however, the emphasis is on chemical fertilizers, especially nitrogen, phosphorus and potassium, the three key elements in plant nutrition. Though far more expensive and more complicated to produce – they're extracted from minerals such as potash, or from petroleum gases – chemical fertilizers have had

a significant impact on crop yields in the Arab East. In fact, a recent FAO study shows that fertilizers were responsible for more than 50 percent of all crop-yield increases in the developing countries between 1965 and 1976 – and that output in the same areas would drop substantially without them.

For the oil producing countries of the Gulf, fertilizers – which once had to be imported – are no longer a problem, since many of them have built fertilizer factories of their own. Qatar, for example, produces 1,000 tons of urea a day from gas, plus fertilizers from organic waste, and Saudi Arabia, which is already self-sufficient in nitrogenous fertilizer, has just built a urea plant with an output of 500,000 tons a year (See *Aramco World,* November-December 1982). Most of this output will be exported to neighboring Arab states still not self-sufficient in fertilizer.

As for putting additional land into cultivation, Arab planners are following two tacks. One involves a technique called "dryland farming," which is transforming barren areas of Iraq, Syria and Jordan into fertile cereal belts. The other is based on massive extensions in irrigation, which, FAO estimates, could almost double the cultivatable land in the region.

Introduced in Mesopotamia and the Nile Valley some 6,000 years ago, irrigation was initially little more than painstakingly dug modifications of natural water courses. As the centuries passed, however, irrigation networks in Mesopotamia increased in size and complexity, and under the Sumerians and Akkadians reached a surprising level of technological efficiency; they involved dikes, canals, aqueducts and various lifting devices such as the water wheel and the leveraged bucket. According to Robert Mc C. Adams, an archeologist, Mesopotamian irrigation peaked just before the Islamic period with the linking of the Euphrates and Tigris rivers, an achievement, Adams wrote, that was "neither matched nor superseded before modern times."

In the seventh century, unfortunately, poor administration by the ruling Sassanians and a disastrous flood in A.D. 628 began to undermine the system so that a century later, according to Adams, nearly 10,000 square kilometers (3,800 square miles) had been abandoned. Under the later Abbasids dissolution continued and then, in the 13th century, came the coup de grace: the Mongols under Hulagu Khan, destroying not only the irrigation network, but also transporting most of the skilled engineers who had maintained it to Central Asia. The canals quickly silted up, the land whitened with salt and the once-fertile fields reverted to desert – conditions which still prevail: only 13 percent of the 437,000 square kilometers (166,250 square miles) of present-day Iraq is considered arable and 32 percent of that must be irrigated if it is to be cultivated.

In the Arab East, this is not unusual. Lack of water has *always* limited farming in this area – and demanded imaginative solutions. About the seventh century B.C., for example, a people called the Sabeans built the great dam and distribution system at Marib in today's Yemen Arab Republic (see *Aramco World,* March-April, 1978), and by Roman times the Nabateans had built catchment dams at Petra – some of which have been recently restored – along with aqueducts, reservoirs and pressure-piped water. Elsewhere, there were other solutions – such as the gravity-fed *aflaj* systems in the Arabian Peninsula (see *Aramco World,* May-June 1983), underground channels, some up to 15 kilometers long (10 miles), linking water sources to fields. A technological triumph, this system prevents water loss from evaporation, and is still a widely-used form of irrigation in many arid countries; in Oman, for example, some 4,000 *aflaj* still provide most of the irrigation and domestic water supplies in rural areas.

Today in the Arab East, the planners are trying or considering even more imaginative solutions. In Saudi Arabia, for example, where the Saline Water Conversion Corporation has $10.2 billion to develop water resources under the current Five Year Plan, scientists are studying the use of *sea* water for irrigation – a method that could revolutionize agriculture in the kingdom's arid coastal regions. Although still in its early stages, university research in Saudi Arabia has already shown that plants can be grown using salt water with concentrations as high as 32,000 parts per million – the same salinity level as the Red Sea. Though yields are low, scientists hope that by genetic engineering they can eventually produce salt-resistant strains of economically important crops that could be grown on the vast area of presently useless sand dunes along Saudi Arabia's lengthy coast.

Another radical idea once considered, but subsequently dropped was the possibility of towing icebergs to the Red Sea from Antarctica and using the melting water to supply drinking water to cities and irrigation to farms along the coast. Though still impractical, and abandoned by Saudi Arabia, two American scientists prominent in "iceberg-water" studies, W. F. Weeks and Malcolm Mellor insist that icebergs might yet provide a feasible and economical solution to the lack of water – particularly for countries like Saudi Arabia – which, they said, "must consider all possibilities..."

In fact, Saudi Arabia *is* considering all possibilities. Planners are already looking into the possibility of importing water from Japan in oil tankers – a proposal discussed this May at a United Nations seminar. Japan has an enormous surplus of fresh water in the northern third of the country, and also dispatches at least one empty super-tanker to Saudi Arabia every day for oil. Since just *one* 400,000-ton oil tanker could carry nearly 360 million liters (95 million gallons) of water each trip – which works out to about 72.1 liters (19 gallons) per Saudi Arab a day for all usages – tankers, with no change in present shipping schedules, could bring close to 133 billion liters (35 billion gallons) of water to the kingdom annually.

Apart from studying such new methods of

overcoming water deficiency, Arab governments are conducting massive investment programs to improve and expand old and already-tested ways of obtaining and conserving water; methods such as dams, pipelines and desalination plants.

In February, this year, for example, King Fahd of Saudi Arabia inaugurated a pipeline that conveys water inland from the world's largest desalination plant at al-Wusta, near Jubail on the Arabian Gulf, to Riyadh, a distance of nearly 500 kilometers (310 miles). An even longer pipeline – 600 kilometers (373 miles) – is planned to carry water from the Tigris and Euphrates rivers in Iraq, across lava flow deserts and mountain ranges to neighboring, water-deficient Jordan.

One of the most rapidly expanding methods of producing fresh water in the Middle East is by de-salting sea water, and, according to the U.S. Agency for International Development, one-third of the world's desalination plants are now located there. In Saudi Arabia, desalination has expanded from two plants treating 576,000 liters of water a day (127,000 gallons) in 1960, to 11 plants processing 1.9 billion liters a day (500 million gallons) today, thus releasing vast quantities of natural water, consumed by cities and industry, for agricultural use.

In addition to these sources, Saudi Arabia can also tap massive quantities of water in what are called aquifers: formations of porous water-bearing strata of rock and sand deep in the earth.

Until the 1930's, when Aramco began to drill for petroleum, few people realized the extent of the underground water resources in the kingdom. But in the early 1960's, in a report called *A Study of the Wasia Aquifer in Eastern Saudi Arabia,* Aramco geologists informed the government that the Wasia aquifer probably contained enough water to meet the kingdom's needs for years to come: some 200 *trillion* barrels of water (see *Aramco World,* July-August 1967). Furthermore, the report said, there were other aquifers almost as large. One aquifer mentioned in the report was the 2,519-meter-deep Turabah aquifer (7,400 feet), thought to be the deepest source of water in the world at that time.

Saudi Arabia is not the only Middle East country turning to water in aquifers. At one experimental wheat farm in Abu Dhabi, 90 deep wells are tapping aquifer water to feed its spraying system, and in 1977 geologists in Egypt announced the discovery of one of the world's largest aquifers: a reservoir 610 to 1,220 meters below the surface (2,000 to 4,000 feet) stretching from the Libyan border to the Red Sea. It is so big, geologists say, that it could "revolutionize" the economics of the Western Desert.

Since the initial discovery of such aquifers, however, conditions have changed dramatically in the Middle East. In the oil-producing countries, multi-billion dollar modernization programs have created new cities and reconstructed old ones, developed industries, modernized housing and built hospitals, schools and universities – all needing water. Also, programs to modernize agriculture have introduced such technology as great rotating booms that spray crops at the rate of 8 liters (2.1 gallons) a second. The net result has been a drop in ground-water levels.

To countries tapping the aquifers, this was troubling news since aquifer water, or "fossil water" as it is called, is irreplaceable; it has been accumulating at a glacial pace for eons and once used up will be gone forever. In some countries the loss was almost immediately apparent: seawater in Qatar is already encroaching on freshwater aquifers at the rate of one kilometer a year (0.62 miles) and the government of the United Arab Emirates (UAE) has had to ban all further drilling of water wells in the country's northern regions.

In Saudi Arabia, to be sure, the quantities of water in the aquifers are still immense. Nevertheless, concerned planners, worried that efforts to expand agriculture might inadvertently start to drain the aquifers, drew up a

national conservation program that, among other things, governs the use of aquifer water. Given the enormous requirements of the new agricultural projects, the effects of these restrictions probably will not solve the water-table problem immediately, but do show the concern expressed by a Ministry of Agriculture and Water executive: "We cannot afford to let a single drop of water go to waste."

To prevent waste, Arab countries are exploring various techniques of conservation. Dirt ditches, for example, which traditionally have fed irrigation water to fields throughout the Arab East – losing, in the process, about 30 per cent through seepage and evaporation – are being replaced by elaborate networks of underground pipes and sprinklers and concrete-lined canals. In Abu Dhabi, wastage is being tackled by an even more radical method; here agricultural scientists have laid a thin carpet of asphalt one meter (three feet) beneath farmland – not only preventing irrigation water from penetrating too deeply into the soil, but simultaneously preventing salts seeping to the surface.

To conserve rainwater – 83 per cent of the land in the Arab East receives less than 100 millimeters a year (four inches) – most Arab countries have also built dams, or are planning to build them, on whatever rivers and water courses they have. Saudi Arabia has built more than 50 small dams throughout the kingdom, Jordan is planning a major dam on the Zerka River, and Syria has constructed a mammoth dam at Tabqa, north of Palmyra. The second largest dam in the Middle East, the Tabqa Dam, 4.5 kilometers long (three miles) is expected to double the total of irrigated land in Syria.

One of the most efficient of the new irrigation methods being introduced into the Arab East is "drip" irrigation, whereby water laden with fertilizers and nutrients is fed under pressure through small-bore plastic pipes and delivered at controlled rates of quantity and frequency to the root zones of each plant. The advantage of this method is that the farmer can give his crop its exact requirements on a regular basis using the minimum amounts of water, fertilizer and labor, yet at the same time obtain a greatly increased yield – as much as 10 times the output of a farm watered by traditional flood irrigation.

The planners, of course, have not always achieved all the results they expected. Despite imagination and money, some very promising proposals have yet to live up to expectations. Arab planners, for example, were disappointed in the failure of programs launched in The Sudan, the one Arab country with unlimited agricultural potential. The Sudan was once slated to become the "breadbasket of the Arab world" (See *Aramco World*, May-June 1978) under a 1975 blueprint combining Arab "petro-dollars" and western technology. According to the original planners, Sudanese farms could be providing 42 per cent of the Arab world's total vegetable oil consumption, 58 per cent of its meat and 20 per cent of its sugar needs by 1985.

Such plans, it should be said, are still thought to be viable, but so far few of the projects launched to implement them have gotten very far – largely because The Sudan simply does not have the trained manpower and infrastructure necessary to get huge, technologically complex programs started. As a result, half-completed projects are not uncommon and the Khartoum government has had to organize a reform program to complete or consolidate the new projects and also restore the country's traditional income from cotton.

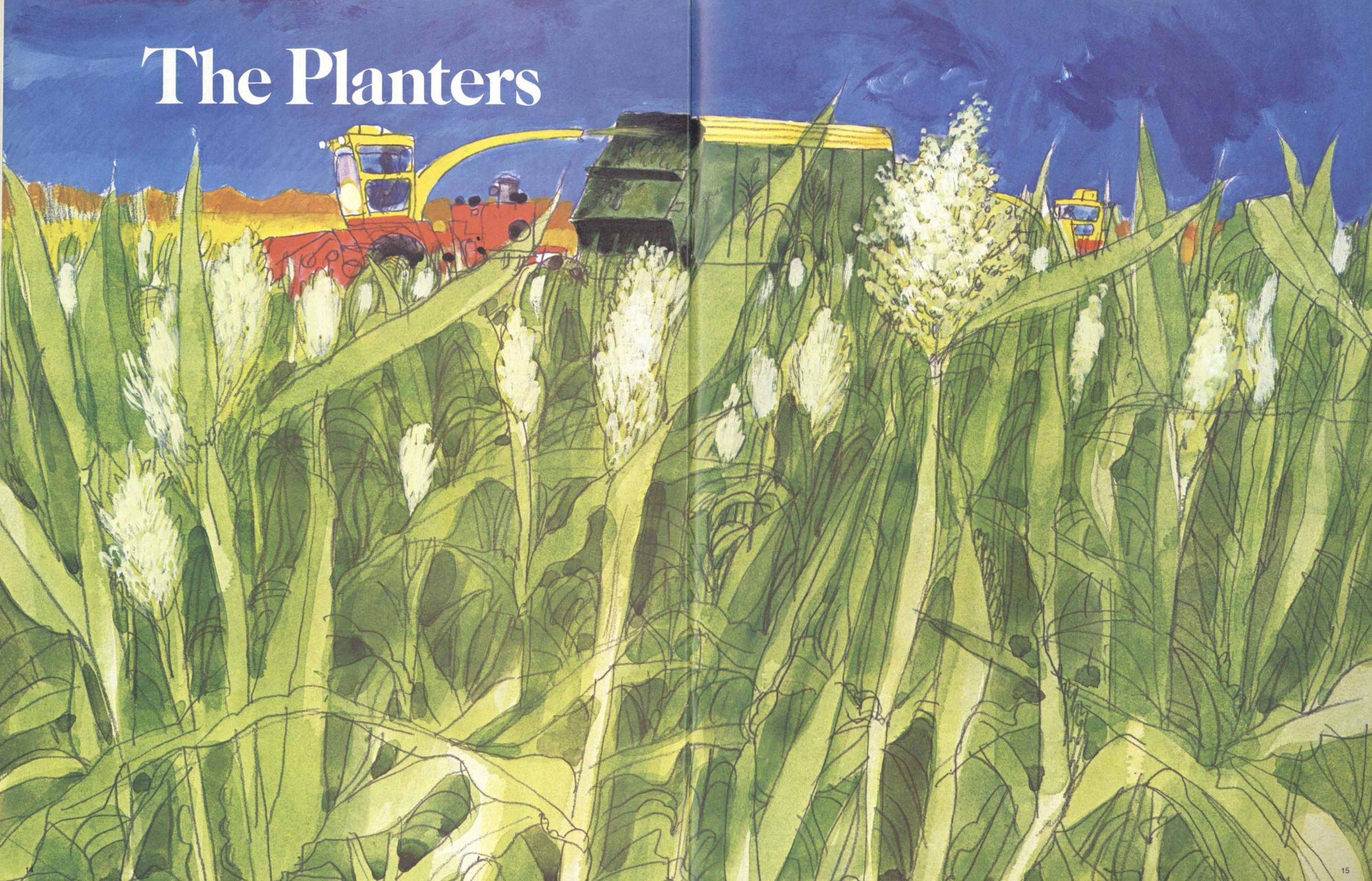
On the other hand, even The Sudan has scored some notable victories. One project that succeeded – despite a lack of roads to the site – is construction of the world's second largest sugar mill and refinery at Kenana, 322 kilometers south of Khartoum (200 miles). Two years after inauguration, its production has surpassed 200,000 tons and, if all goes well, should reach peak capacity of 333,000 tons by 1985 – a reminder that The Sudan, under the right conditions, can fulfill the planners' dreams.

Another Sudanese project that has been quietly proceeding despite enormous problems is the Jonglei Canal – one of the greatest hydrological undertakings of the century. By April the 278-kilometer canal (173 miles) was nearly half dug and much of the earlier hostility by nearby peoples – who expected severe dislocations and ecological damage – had been dissipated. Even better, unforeseen opportunities for work and food production had begun to surface.

The main purpose of the Jonglei Canal, which will run from Bor to Malakal, is to save some of the enormous volume of Nile River water; an incredible 4.8 billion cubic meters a year is now diverted into the great swamp called the Sudd – where it evaporates. By carrying water around the Sudd and emptying it back into the Nile, the Jonglei Canal will add an immense amount of water to the Nile's already tremendous flow and help irrigate a proportionate acreage of new Egyptian farmland. In addition it will open up some 81,000 hectares (200,000 acres) of Sudanese land to farming, and five million acres of pasture land. Last, an unanticipated bonus, it will make it possible for the peoples of the area to develop a fishing industry. The Sudd's fishing wealth is being developed by an FAO fisheries team, which has already set up two 80-man cooperatives.

Such projects, of course, require great amounts of money – as well as farsighted, imaginative planning. The planners, for instance, have begun to experiment with "remote sensing," a form of "color enhanced" photography called "imaging" from satellites. Imaging, scientists say, can pick out vegetative growth and traces of ancient water channels – aids to tapping aquifers on a national scale. This is important in the search for water because aquifers often extend over vast distances which normal aerial photography cannot capture or evaluate. For planners, even the leading edge of technology can be sharpened for use in greening the arid lands of the Middle East, and guaranteeing enough food for all their peoples.

The Planters



By the wreckage of a bombed-out house in Lebanon this spring, a farmer named Youssef Sarkis paused in his work, leaned heavily on his hoe and said wryly, "If I had a house, I'd invite you to sit down and drink coffee."

Sarkis, however, doesn't have a house. Like most houses in his area – Damour – it was destroyed during the eight years of war and invasion that have ravaged Lebanon and left its fields, orchards and plantations stripped or burned.

Throughout Lebanon similar conditions have been reported. In the rich Bekaa Valley, for example, half of Lebanon's entire agricultural output will be lost this year, according to government sources, because of continuing tensions and problems left by years of conflict.

Yet there is some progress – thanks to men like Youssef Sarkis and other Lebanese planters who this year, for the first time since 1976, have returned to the Damour Plain, a narrow strip of fertile land by the sea 20 kilometers south of Beirut (12 miles), where, before the war, the scent of orange blossoms perfumed the air and rows of banana trees marched to the edge of the Mediterranean and the banks of the Damour River.

Up at dawn each day, Sarkis makes his way to Damour through the military checkpoints that ring Beirut and usually works until dusk; he is nursing a new crop of banana trees to replace those cut down during the war. And he is not alone. Down the road, his neighbor, Tanious Matni, was just as busy. The first farmer to return to Damour after the 1982 Israeli invasion, Matni was already harvesting his first crop of cucumbers and tomatoes – grown in newly-erected plastic greenhouses – this May.

Eventually, Sarkis and Matni hope to rebuild their bombed-out homes and bring their families back to Damour. But their first priority is the land. "The plain is our base," explains Jamil Chkaiban, head of a cooperative formed recently by the farmers of Damour to reclitivate the once-luxuriant Damour plain. "If we don't rebuild the plain we can't get credit to rebuild our houses."

Rebuilding will not be an easy task. The orchards and banana plantations for which it once was famous have all been destroyed and will take years to restore. There are many unexploded bombs in the fields and as fast as the farmers patched up the plain's dilapidated irrigation channels this spring, tanks and other military vehicles damaged them. But the most pressing problem is finance. "We have nothing – not even tools," says Chkaiban.

Some help has already been forthcoming from a somewhat unexpected source – the United Nations Save the Children Fund. "Parents' incomes are at the root of all children's problems," explains Dr. Andre Karem, the fund's Beirut director. "We work with the farmers so that the needs of their children will be taken care of." So far the fund has given some 40 loans to farmers in Damour totaling about $100,000. Meanwhile, a much bigger aid package was being put together by the International Fund for Agricultural Development (IFAD): more than $32 million to repair rural roads, distribute cows and goats to dairy farmers and extend credit to apple growers. And even this is a drop in the bucket compared to the farmers' total needs. The years of conflict in Lebanon have had a disastrous effect on the country's agriculture – destroying orchards, damaging irrigation networks, decimating livestock and driving farmers from their lands. As a result, says the United Nations Food and Agriculture Organization (FAO), $244 million is needed over the next five years to rehabilitate Lebanese agriculture.

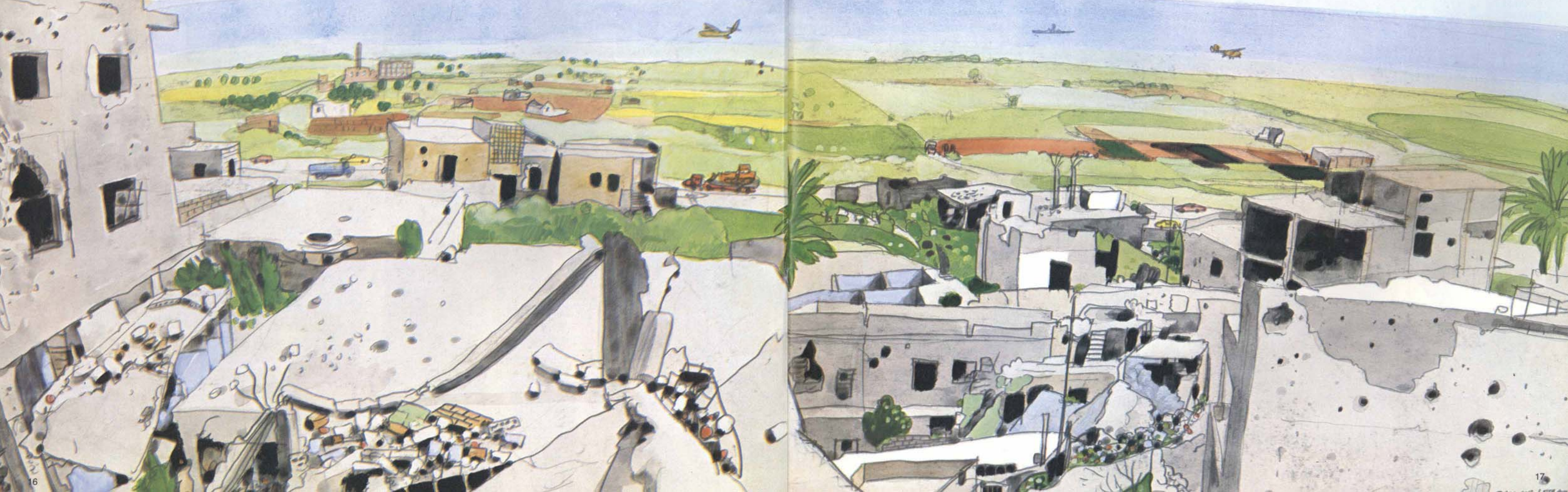
The first step in that rehabilitation, says Samir Abu Jawdeh, adviser to the Minister of Agriculture, is to resettle the rural population. "We must get them back from the slum areas that have grown up in the cities... and this can only be done if we provide them with the same benefits as their countrymen enjoy in the cities." Mr. Abu Jawdeh is confident, however, that Lebanese agriculture can bounce back. "We have the means – the sun, the water and the know-how. All we need is peace."

One unexpected problem is that even if peace is fully restored, some of Lebanon's farmers are unlikely to return to their land since the massive urban construction programs that are planned have sent the prices for farmland on the outskirts of the cities skyrocketing. "The farmers are selling their land, putting the money in the bank and living on the interest," says Axel Baille, FAO's chief representative in Lebanon. "They can earn far more that way than they can from any crop."

Again, though, FAO can report some progress, thanks to the fact that there *are* ways to make more money from farming than from real estate speculation: growing crops under glass. "Only greenhouses can compete with land speculators," explains Baille, "because the farmer can grow up to eight times more in them than he can outside."

Today's greenhouses, as it happens, are built of plastic or fiberglass rather than glass, but the effect is the same: a controlled environment. And they are already being used extensively throughout the Arab East – particularly in those countries where conditions are extreme. Saudi farmers, for example, are having considerable success raising cucumbers and tomatoes in enclosed, environment-controlled conditions. They even do it without using any soil.

Perhaps the most-revolutionary of the new growing systems to sweep the Arab East, this technique is called hydroponics. In one type of hydroponics called "NFT" – nutrient film technique – plants are grown in plastic troughs through which runs a plant food and fertilizer solution. Housed inside plastic or fiberglass greenhouses, where temperature, humidity and sunshine are regulated by automatic systems, crops of tomatoes and cucumbers can be harvested just four to 10 weeks after planting. Although such installations are expensive, they are much more efficient and less wasteful than conventional growing methods and are ideally suited to Middle East countries where



HYDROPONIC GREENHOUSE
DHAHRAN SAUDI ARABIA.

capital is plentiful but labor and water are short.

In many such ventures in Saudi Arabia, farmers are gearing up for an annual production of 40 kilograms per square meter of tomatoes (88 pounds) and 60 kilograms per square meter of cucumbers (132 pounds) – eight times the yield of a traditional farm. One Saudi dairy farm even has a back-up hydroponics facility that, in the event of a conventional fodder crop failure, is capable of growing from seed one ton of fresh grass every eight days.

Another greenhouse-growing technique being introduced to Arabia is "sand culture" – the cultivation of plants in pure sand irrigated with a nutrient-packed drip. The advantage of using sand – apart from the obvious fact that there is plenty of it – is that, unlike soil, it is relatively salt free. Although less expensive and easier to operate than hydroponics, sand culture yields similar results. At Saudi Arabia's al-Hasa oasis, for example, crops of sand culture-grown cucumbers are flourishing in two 1,000-square-meter fiberglass greenhouses (10,800 square feet), in which the original soil, containing 20,000 parts per million of salt, had been replaced by sand, containing only 3,000 parts. Nutrients dissolved in water are fed to the plants every four hours by drip irrigation to make up for the lack of nutrients in the sand, and temperature and humidity kept at optimum levels by large fans that suck air through water-soaked pads in the wall of the greenhouse.

Since plastic and fiberglass greenhouses play a key role in vegetable production in arid areas of the Arab East – but at the same time are restrictive and relatively expensive – Gulf planters are constantly on the lookout for new ways to save both space and costs. Several new techniques now under study are based on the interdependence of different crops. In one such method, pole beans and corn are grown close to each other so that the beans climb round the corn stalks, thus saving space, while at the same time the beans, which produce nitrogen in their roots, help to fertilize the corn – which needs nitrogen. Another scheme uses water pools in which floating styrofoam boards hold lettuce plants, and melons are grown on A-frames over them. Catfish are raised in the pools and their waste provides nutrients for the lettuce and melons. When the lettuce boards are removed at harvest time, the melons can be shaken off into the water unbruised, thereby reducing the need for expensive manual labor.

A new method of outdoor farming being introduced in some parts of the Arab East is "dryland" farming – a technique enabling wheat to be grown without irrigation on land that receives as little as 5.9 centimeters (15 inches) of rain a year. In Iraq, for example, dryland farming is transforming land once considered infertile into viable farms. At Erbil, in the north, the Ministry of Agriculture and Agrarian Reform is developing 5,000 hectares of land (12,350 acres) and at Jezierah, west of Mosul, a further 10 million hectares (24,700 acres). Despite initial results reported as dis-

appointing – because of an exceptionally dry year – the ministry has high hopes for this method.

Originally developed on the Great Plains of the United States, dryland farming differs from the traditional fallow method – growing grain one year and nothing the next – in several ways. Traditionally, the farmer would have left his field bare when not growing grain – which cannot be grown on the same land each year – leaving the soil unprotected against erosion by wind and flash floods. In dryland farming, after harvesting his cereal, the farmer lets sheep or other livestock graze on the field, their manure serving to regenerate the soil then the clover-like plant of the alfalfa family – called "medic" – is planted, to "fix" nitrogen needed in the soil, and, at the same time, bind the particles of earth together, preventing soil erosion, and also provide fresh fodder for the livestock. The farmer then replants his field with grain.

Although ingenious efforts at soil conservation have been made in the Arab East since early times – such as terracing in Lebanon and southern Arabia – soil erosion and other forms of land degradation (gathering firewood and over-grazing), are today major problems in the region. According to a UN survey, no less than 98 percent of the Near East is subject to desertification, and urgent efforts are now being made to reverse this process.

One of the most effective efforts involves trees – which *can* grow in the desert. In the northeast corner of Saudi Arabia, for example, an ambitious tree-planting project is underway: the creation, in effect, of an artificial oasis in one of the world's driest regions. The tree planting – actually a massive landscape project – is part of the eight-year construction of the King Khalid Military City, a brand new city being built from scratch in a remote part of the kingdom that experiences the full range of arid zone climatic extremes – temperatures reaching 45 degrees centigrade (112 degrees Fahrenheit), rainfall averaging a paltry seven centimeters annually (2.5 inches) and winds up to 60 kilometers an hour (37 miles per hour). The planters, therefore, had to carefully select trees that, while being both functional and ornamental, would survive wind, heat and aridity, tolerate high salinity, grow rapidly and require minimal care. Eventually, the specialists came up with a list that included the Australian pine, the Arizona cypress and the Jerusalem thorn as well as native eucalyptus, tamarisk and acacias.

The planters had also to carefully prepare the soil, eventually arriving at a balanced mix of sand, silt, and clay with a slight addition of acid for eucalyptus and acacias. Irrigation, too, had to be carefully controlled to avoid saturation; if the soil is constantly kept wet, root deterioration is likely to result. The planters decided on a cycle of two to three days on, and two to three days off to prevent waterlogging, which causes root rot and builds up salt when too much water is applied to saline soils like those found at King Khalid Military City. To remove excess water, and salt, an underground network of pipes was installed much like the ones used in normal drainage of streets, except that they are perforated, thus providing a second level of drainage.

With maximum daily wind velocity in the range of 10 to 20 knots – and up to 30 knots three months or so per year – one of the key aims of the greening scheme is to provide protection from wind-borne dust and debris. Indeed, creation of windbreaks is one of the most important aspects of the tree planting scheme.

To reduce the wind and intercept flying particles, planting is arranged progressively in the windbreak. At ground level, tough bedding plants, primarily succulents, are used to break and lift the wind as well as to trap any debris at ground level, and at the next level hardy shrubs of varying heights continue to lift the wind and also filter sand and dust. Next comes a first baffle of evergreens, then taller deciduous trees, and finally, a third baffle, also of evergreens, and rows of small deciduous trees which reduce the turbulence immediately leeward of the tall evergreens and provide final filtering.

Further out, the landscape plan provides a large-scale belt of trees also aimed at controlling wind and dust, but providing a recreation area too, as well as a sector for future residential expansion. Located immediately beyond the city's perimeter road, this area is to be graded in ridges and hollows, in order to effectively control wind, assist with supplementary irrigation and encourage surface vegetation.

Although still in its early stages, the King Khalid Military City tree-planting project qualifies as an innovative effort to apply present-day technology in irrigation, underdrainage and plant propagation to an arid zone. It also explores the possibility of developing artificial oases and adapting them to the demands of the 20th century.

Another major problem plaguing planters in the Arab East is soil salination, the accumulation of salts in soil. The greatest potential hazard to any irrigation project, it results from the application of either too much or too little irrigation water. If too little water is applied, salts accumulate near the surface because there is not enough water to wash them away, while if too much is applied the soil becomes waterlogged and, as it evaporates, leaves a white, life-killing crust on the fields.

One area where this problem is particularly acute is Syria's Euphrates Irrigation Project. An enormous undertaking even by international standards, this project, which includes the great Tabqa dam is the backbone for economic development in eastern Syria. Aside from producing electricity and creating a fishery, the giant dam was to have enabled the country to irrigate an extra 640,000 hectares of land (1.6 million acres) during the next 30 years – more than double the present amount.

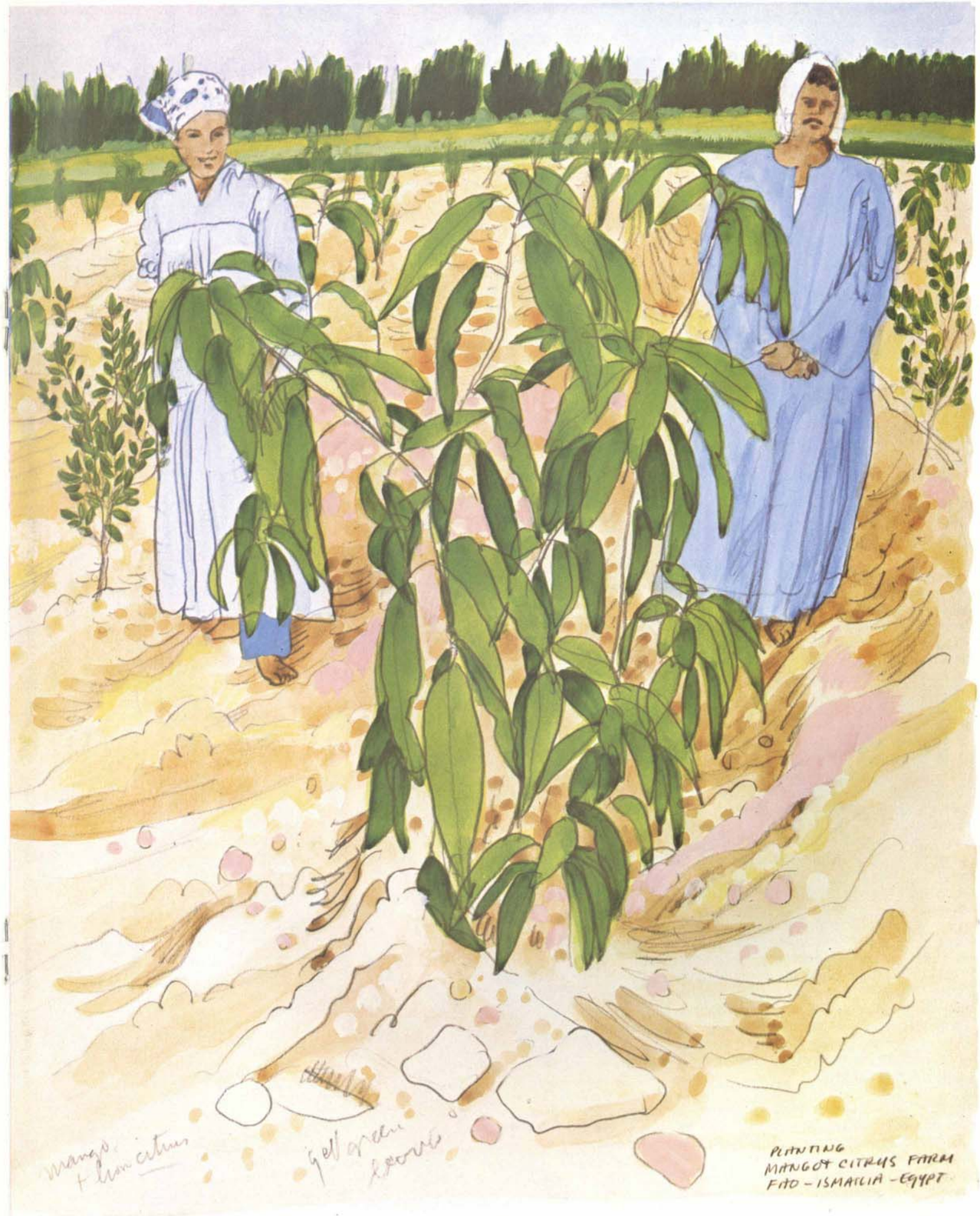
Salination in Syria is a problem that goes back to the Sumerians; their fields were frequently abandoned because of salinity. And today, despite modern methods of coping with this problem, fully 50 percent of Syria's land in the Euphrates region is affected by some degree of salinity. Since work on the dam began in 1974, original plans to irrigate 240,000 hectares by 1980 (593,000 acres) had to be curtailed because of soil salination.

Since 1981, therefore, the emphasis has been not on how fast the project moves, but that it moves in the right direction – with particular attention being paid to water and soil management. New irrigation networks are being built and new farms planted on the foundations of past experiences – using, for example, small basins, in which irrigation water can be controlled, rather than furrows, where it cannot. With these problems nearly controlled, agricultural experts say, it is not unrealistic to expect positive results from Syria's Euphrates project in the near future.

In Iraq too, bold steps are being taken to restore the ancient land of Mesopotamia – birthplace of organized agriculture – to its former fertility. Fully one-third of investment funds in the government's last two Five Year Development Plans have been earmarked for agricultural programs, such as desalination and mechanization of production methods, and so far, the results have been encouraging: 36 irrigation projects were completed under the first Five Year Plan (1976-80), including 20 in the Tigris Valley and 13 on the Euphrates River, providing water for a total of five million hectares of new land (12 million acres).

Egypt too is trying hard, but the results are sobering. Although the country has already reclaimed over 900,000 hectares of "new lands" (2,244,000 acres), mainly along the desert fringes of the Nile Delta, less than 60 per cent of the reclaimed land is actually being farmed. The rest has been lost to urban expansion, new industries and roads, and possibly as little as 35 percent is being cultivated with a margin of profit.

According to IFAD, the principal problems have been faulty technical design of irrigation



systems, poor construction standards – which have led to rapid deterioration of works – and bad management. As a solution IFAD is proposing closing down state farms, rehabilitating irrigation networks and turning over reclaimed lands to small landless farmers. "Comparative studies of cases where settlement has been carried out have shown that smallholders have consistently outperformed the state companies in terms of yields, cropping intensities and soil amelioration," says IFAD.

IFAD's first target is none other than the West Nubariya Agricultural Company (WNAC) a company intended to be a model of mechanized state farming in the Nile Delta. WNAC has been running up an operating loss on the order of $142,000 a year due to low productivity. By shutting down WNAC and converting its 84,000 hectares of reclaimed land (207,500 acres) into owner-occupied smallholdings, IFAD not only hopes to produce substantial food supplies for local markets and specialist crops for export, but also to provide a livelihood for some 10,000 people – compared to WNAC's 2,500.

Furthermore, IFAD hopes that settlements of smallholders will set a "valuable precedent" – as an alternative to large state farms – and presage a policy which "recognizes the fundamental contribution which small farmers can make to national economic progress."

The small farmer is already playing one key role in fighting the Arab food deficit – by assisting agricultural scientists in "on farm" research into faba beans in the Nile Valley of Egypt and northern Sudan. One of the main staples of the region, faba beans are used to make *ful medammas*, a breakfast and supper dip, and *falafel*, a tasty sandwich. Numerous constraints, however, limit faba bean yields, including pests and weeds, and the conflict of planting and harvesting times with those of other crops. As a result local production is unable to keep pace with growing demand.

The aim of the Nile Valley Project, which is organized by ICARDA and financed by IFAD, is to increase faba bean production by closing the gap between yields obtained at research stations by scientists and those obtained by farmers in their fields. To do this, Egyptian and Sudanese scientists are comparing new ideas and technology with the farmers' own time-tested methods – and finding that the best results are produced by a combination of both. Results of on-farm trials, for example, have shown that the greatest net return from the smallest operating capital is achieved by combining the recommendations of the scientists on variety, weed control and planting methods with the traditional ways of irrigation and pest control used by the farmers.

The Nile Valley Project has four more years to run, but it has already shown that working together the planners and the planters may one day close the gap not only between their respective outputs but also between the quantities of food grown and the amount eaten in the Arab East. .

The Progress

In some areas of the Arab East, the green revolution is well underway. One area is the Jordan Valley. Others, surprisingly, are in the Arabian Peninsula.

Agricultural advancement in Jordan is not particularly unusual since this country is part of the famous Fertile Crescent, the arc of arable land stretching from the Mediterranean to the Arabian Gulf. But the greening of Arabia is definitely surprising since the Peninsula has only a few areas where crops can survive, let alone thrive. Last year, however, in a remarkable demonstration of what money, technology and modern management can accomplish, market gardeners in the United Arab Emirates (UAE) were growing tons of tomatoes and cucumbers in the desert, and in Saudi Arabia farmers grew $1.5 billion worth of crops – achieving nearly 50 percent self-sufficiency in wheat and near self-sufficiency in dairy products, self-sufficiency in eggs, and a surplus in dates.

Such results, of course, do not come cheaply. To achieve them, Saudi Arabia has invested billions of dollars in agricultural equipment, fertilizer plants, expert assistance and new, costly farming techniques by which crops can be grown in what is essentially sand. Its farmers, furthermore, have tapped large quantities of the kingdom's most precious resource: underground water.

In view of such costs – and huge surpluses of food in Europe and America – some skeptics have questioned the wisdom of the Saudi agricultural drive. But this view ignores the Saudi government's wish to cut the kingdom's massive food import bill – $6.7 billion in 1982 – and reduce the country's dependence on imported food that political and economic developments far beyond its borders might affect at any moment. To secure an adequate home-grown food supply for the future, therefore, the Saudi government is placing great emphasis on farming – spending $2.4 billion on agricultural development in its Third Five Year Development Plan (1980-85) and offering an unusually attractive package of incentives to private farmers.

The government, for example, distributes farmland and irrigation water, pays to fly cows into the country, subsidizes 30 per cent of the cost of poultry and dairy farming equipment and 50 per cent of fertilizer and animal feed, offers various types of interest-free loans on agricultural projects, and buys rice, corn, millet, barley and dates from farmers at guaranteed prices.

One decisive subsidy in shaping Saudi agricultural output is the price paid for wheat by the state Grain Silos and Flour Mill Organization (GSFMO) – currently about $1,000 a ton. Roughly six times the world market price, this subsidy has helped boost Saudi wheat production from 3,000 tons in 1977 to more than 500,000 tons in the 1983 season.

Saudi Arabia, surprisingly, is also doing well in dairy farming. Although few enterprises may seem as difficult as raising cows in the desert, the average yield of some Saudi herds compares favorably with those in Europe, and local production now meets nearly 70 percent of the country's dairy needs. Saudi officials, furthermore, estimate that by the end of 1985 the kingdom will have 30 major dairy farms – double the present number – with 40,000 cows producing 100,000 tons of milk a year.

One of the most ambitious dairy projects so far is the Saudi Arabian Agriculture and Dairy Company (SAADCO). Located at al-Kharj, 95 kilometers from Riyadh (59 miles), SAADCO is the largest integrated dairy farm in the Middle East – complete with over 12,000 cows and 2,500 hectares of newly irrigated land (6,178 acres) to produce fodder, and on-site milk processing plants.

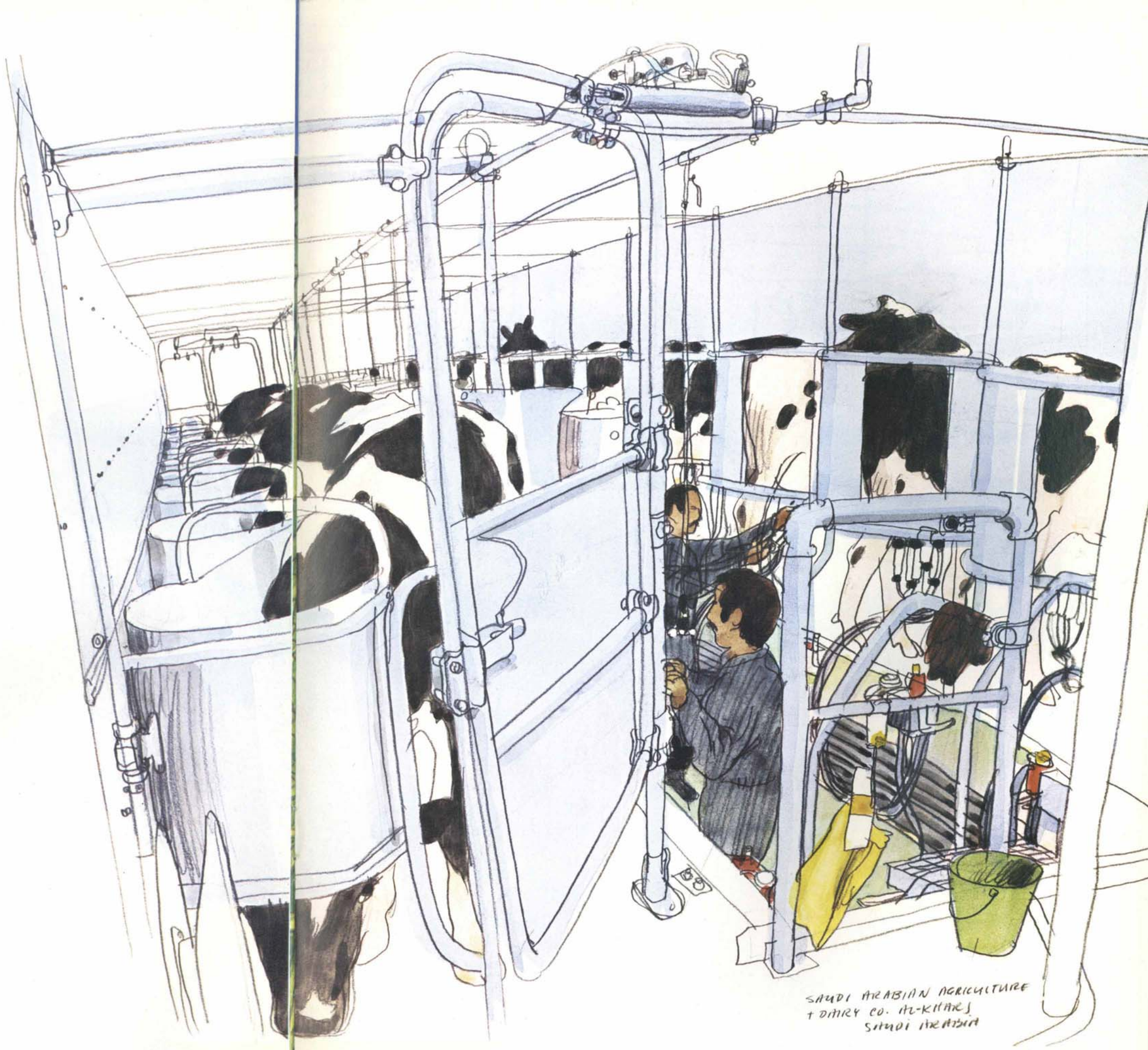
The 60-kilometer-square SAADCO estate (23 miles-square) has been described by one agribusiness executive as "almost surreal." On what was barren desert less than four years ago, luxuriant green alfalfa now grows at the rate of a crop every three weeks – *six* in summer – and healthy Holstein-Frisian cows produce 100,000 liters of milk a day (26,400 gallons).

The cows are kept in open sand corrals with canopies to shade them, sprinklers to keep them cool and some incredibly sophisticated technology: computers to monitor the herd's overall performance and provide details on each aspect of its daily life, and milking machines that in effect have two "speeds" – one a gentle massage, the other rapid milking – both automatically controlled by the cow's own physiological response.

From the milking sheds, the milk is piped through a cooling plant and then ferried by tanker to a highly automated on-site dairy, which at full capacity can process 75 tons a day of milk products: pasteurized milk, yoghurt, *labneh* (fermented milk), white cheese and ice cream. These products are delivered by a fast fleet of refrigerated trucks to distribution centers in Riyadh, Jiddah and Dammam. Poultry operations, elsewhere in Saudi Arabia, meanwhile provide the domestic market with 80 million chickens a year, 29 per cent of national consumption, and 1.1 billion eggs.

In Saudi Arabia's drive to develop agriculture, water must be carefully husbanded – particularly "fossil water", the great underground reservoirs of water accumulated over centuries. Though estimates suggest that there may be sufficient water in these aquifers to meet present irrigation needs for at least a century, uncontrolled withdrawal could deplete these resources at an unacceptable rate.

This, some observers say, could cause problems since water, not oil, as Minister of Agriculture and Water Abdul Rahman al-Shaikh frequently stresses, is Saudi Arabia's most precious resource. Except in the mountainous Southern Province of Asir, where the government has built more than 40 dams since 1977 and which has adequate rainfall to sustain agriculture, most of the kingdom's farmers



MILK PROCESSING PLANT
SH. AGRICULTURE + DAIRY CO
AL-KHARJ.
SAUDI ARABIA.

depend mainly on fossil water; it is the source of most springs and wells, including those that water the country's traditional oases.

At the moment, one new method of irrigation in use in Saudi Arabia is the so-called "pivot system," whereby water is pumped from aquifers and sprayed on crops like rain through vast systems of motorized perforated pipes that rotate in a circle. On one farm alone, near Riyadh, over 50 240-horse-power engines are pumping water from 95 meters underground (300 feet) at a rate of eight liters a second (2.11 gallons) to be sprayed by 370-meter-long irrigation arms (1,100 feet) over 42.5-hectare-area circular plots (104 acres) at a rate equivalent to a brimming bathtub every second.

The results are spectacular. Pivot systems produce three times as much animal fodder per hectare as in the West. But again there are drawbacks. One is that close to 30 percent of the pivot water is thought to evaporate, according to men involved with pivot systems. Another is that such intensive use of water may use up supplies too quickly. Experts say, therefore, that intensive grain farming needs to be carefully controlled.

In addition to direct financial encouragement to farmers, the government also supports substantial agricultural research, education and pest control programs. The Ministry of Agriculture maintains over 100 offices throughout the kingdom which send out teams to spray crops free of charge. The ministry also runs a string of experimental farms that study local crop problems, livestock production, fish farming, methods of sand stabilization and seed research. Development of improved strains has already brought about an improvement in the quality of vegetables, and recently-introduced potato growing has been particularly successful in some areas, producing a 1982 harvest of 10,000 tons.

Now one of the fastest growing economic sectors in the kingdom – its growth rate doubled in the first 12 months of the Third Five Year Plan – agriculture has spawned a number of multi-million dollar enterprises and a host of agriculture-related industries. In the Eastern Province, for example, entrepreneurs have opened nurseries, agricultural supply houses and even landscaping businesses, some on land that was merely *sabkha* (salt flats) and sand just a decade ago. They serve some 300 to 400 farmers primarily, but because industrial and residential estate development has bred a demand, they also design, construct and maintain tree-lined roadsides, gardens with fountains and esthetically pleasing frontages for companies and personnel moving into new properties.

One major firm in the area specializing in both agricultural supply services and landscaping is the Saudi Agricultural Services Corporation (SASCO) based in Dammam, with an 8.1 hectare (20-acre) nursery near Qatif. A company with a multi-million dollar annual turnover today, SASCO was started in 1974 as a small flower-importing and sales company in a 12-square-meter shop in Dammam (130-square-feet). According to general manager Sa'id Aoudeh, the firm now grosses $5.3 million a year selling such plants as melia trees from Spain, raspberry bushes from Iraq, various flowering shrubs, bushes like hibiscus, lantana and bougainvillea and even specially grafted cacti from Japan.

Aoudeh dates the "takeoff" point for the landscaping side of SASCO to 1977 when the company was awarded the "very first" landscaping job at Jubail, a giant industrial city being built on the coast north of Dammam (*Aramco World*, November-December 1982). But he counts this $174,000 contract as "small" compared to a new $30.4 million contract described by Aoudeh as "one of the largest landscaping projects ever awarded at Jubail." That contract is to landscape a 42-kilometer road network (26 miles) including construction of shoulders, installation of a modern irrigation system – with a 700-horsepower pumping station and a 3.8-million-liter water reservoir (1 million gallons) with automatic controls and sensors – and planting some 17,000 trees, mainly acacia, ficus and melia.

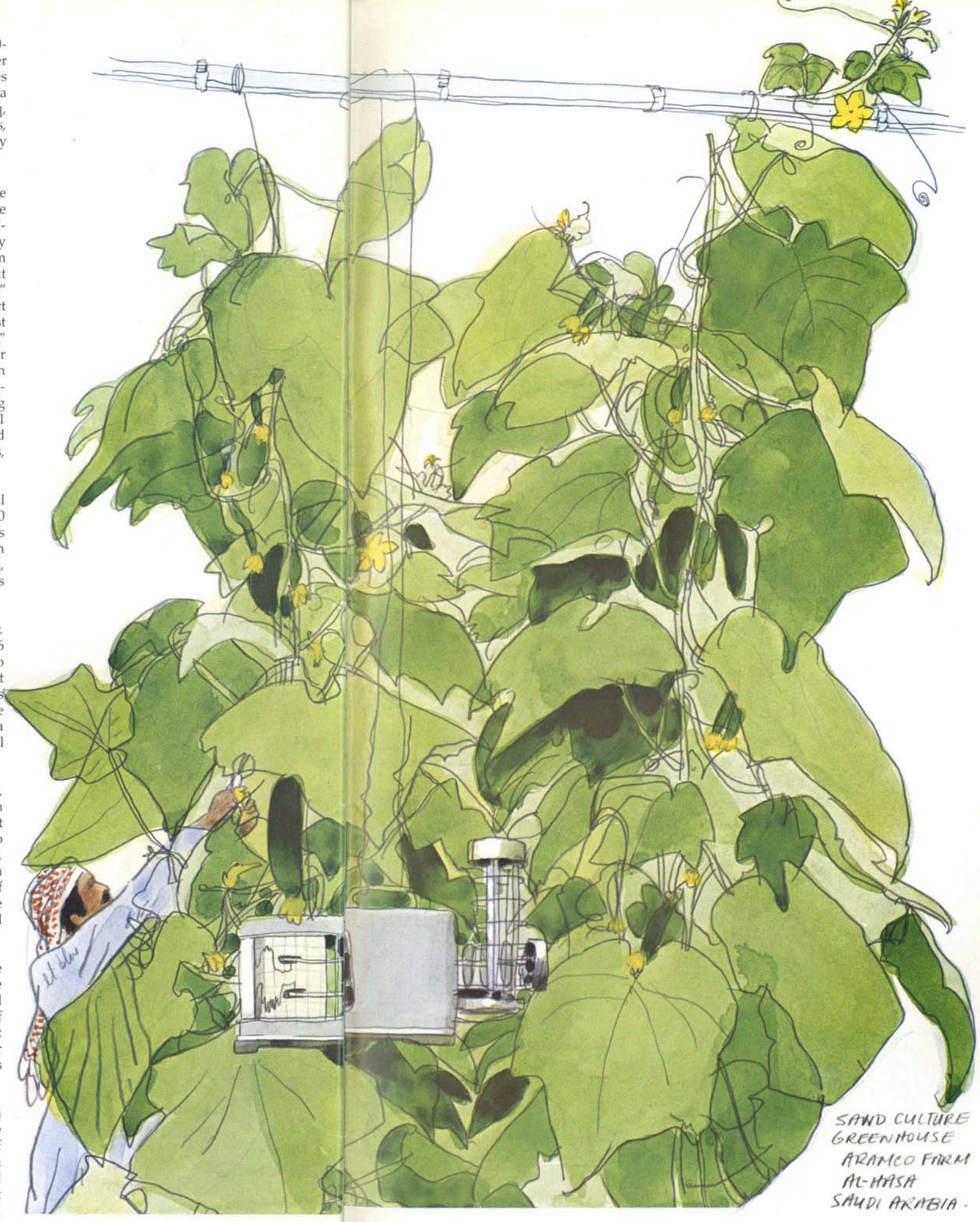
Reflecting both the achievement and potential of the agricultural sector in the kingdom, 400 companies participated in Saudi Arabia's first-ever agricultural exhibition in Riyadh in 1982, 420 took part in Saudi Agriculture '83, and most of the space at next year's exhibition is already sold.

The future, of course, is uncertain, but Dr. al-Shaikh recently voiced hopes that by 1986 Saudi Arabia would be in a position not only to grow most of its own food, but also to export wheat, dairy produce, poultry and vegetables to neighboring Gulf states – a remarkable achievement in such a short period of time for a country with so few natural agricultural resources.

In the UAE, progress has been less dramatic, but is nevertheless instantly visible. Fifteen years ago, for example, passengers arriving at the Abu Dhabi International Airport had no doubt that they were in a desert land, but today, as they drive into town along a road lined with trees and gardens, they may well wonder if they will see any desert at all. The people of the Emirates have a passion for growing things and in recent years have indulged themselves.

The UAE tree projects were started in the late 1960s, but really took off in 1972 when the Sadiyat Island project was initiated by the Arid Lands Research Center to solve the problem of cultivation in an artificial environment; it succeeded so quickly that a bright future for agriculture in the Emirates already seems assured.

Al-Ain is a case in point. Not long ago, it was a dusty desert town, little different from the sandy wastes around it, but today, as a result of judicious use of water, the dust has been transformed into beds for trees, shrubs and flowers that abound, even in traffic circles. But the Emirates have practical plans as well.



SAND CULTURE
GREENHOUSE
ARAMCO FARM
AL-HASA
SAUDI ARABIA.

Already private farms close to the center of al-Ain, thanks to government aid with respect to technology and equipment, are sprouting, the fields rich in alfalfa, cucumbers, lettuce and cabbage – the cabbages in sand covered with aqua paper to retain moisture from drip feed. In another example, UAE farmers are producing commercial crops in a full hectare of linked greenhouses (2.5 acres). At one end of the building cool water is sprayed onto a series of vents which atomize the water before it is sucked through the greenhouses by giant extractor fans that keep humidity and temperature at optimal levels. In one five-month season they have already grown 280 tons of produce.

In Abu Dhabi the Ministry of Agriculture also runs a 500-hectare experimental wheat farm (1,235 acres) at which double lines of conifers protect the field and spray irrigation arms are fed by some 90 wells tapping aquifer water. In addition, FAO experts at Hamranya are trying to find out what grows best in local conditions, exploring, for example, the commercial possibilities of citrus fruits, while at a model dairy farm others are working with 450 Frisian milk cows which have been there for nearly 20 years and have been used to breed acclimatized cows.

Of all the examples of progress, none is more dramatic than the 100-kilometer-long Jordan Valley (60 miles), where, in 1981, valley farmers grew $141 million worth of fruits and vegetables – compared to $49 million worth in 1977 – and accounted for just over 63 per cent of the country's entire output.

Broken down, that total includes 162,000 tons of tomatoes, 58,911 tons of eggplant, 34,031 tons of summer squash, 33,411 tons of cucumbers, 16,793 tons of lemons, 12,456 tons of oranges, 11,500 tons of tangerines, 6,683 tons of bananas, 2,649 tons of grapefruit, plus impressive quantities of wheat, barley, onions, string beans, hot peppers, cabbage, watermelons, lettuce and potatoes.

Other statistics are equally impressive. In 10 years, development has increased the valley's total cultivated and irrigated areas to 21,000 hectares (51,870 acres) – and double- and triple-cropping of the same land during the October-to-May seasons has boosted the actual area cultivated to about 40,000 hectares a year (98,000 acres). Furthermore, increasingly sophisticated farm management, crop rotation and advanced technology could increase output sharply in the 1980s, and construction of the proposed Maqarin Dam on the Yarmuk River – expected to start soon – could increase the total of irrigatable land to 36,000 hectares (98,000 acres).

To a great extent, this bounty stems from exceptionally dependable sources of water: the Yarmuk and Zerka rivers and nine contributory wadis, flowing out of the eastern hills, pour 636 million cubic meters of water into the valley annually – (168 billion gallons).

In addition, the valley, situated 200 to 400 meters *below* sea level (660 to 1,300 feet), is


dead sea

warmer in winter than the surrounding uplands; this means that its farmers can grow vegetables in the off-season – and get premium prices for them. Another advantage is its proximity to other Arab countries; Jordanian vegetables picked in the morning can be on dining room tables in the Gulf within 48 hours.

Water, climate and location, however, are but parts of the Jordan Valley story. Though increased agricultural output is the most obvious accomplishment, the change in people's attitudes towards working and living in the valley is the most significant. As Dr. Munther Haddadin, acting president of the Jordan Valley Authority (JVA), said: "It's easy to build irrigation projects and houses or schools. The really difficult challenge is in changing people's attitudes towards education, social welfare, self-reliance, civic mindedness, child-rearing, and all the other elements of an educated, enlightened population. It's a slow process..."

In the Jordan Valley, however, this process is well underway. Young people who had drifted into the valley seeking seasonal work now ponder the option of buying a house there and students who once migrated to the cities are taking some of the new jobs in education, health care, banking, agricultural services, transport, government services, and a whole range of retail and commercial fields. Until 10 years ago, such students wouldn't have dreamed of returning to valley life. Now, however, they can, and already there are examples of lawyers and teachers leaving their jobs in Amman and Salt, returning to the valley, and in some cases even taking up farming. As a result, the population of the valley has begun to climb again – to about 100,000 people, most of them permanent residents.

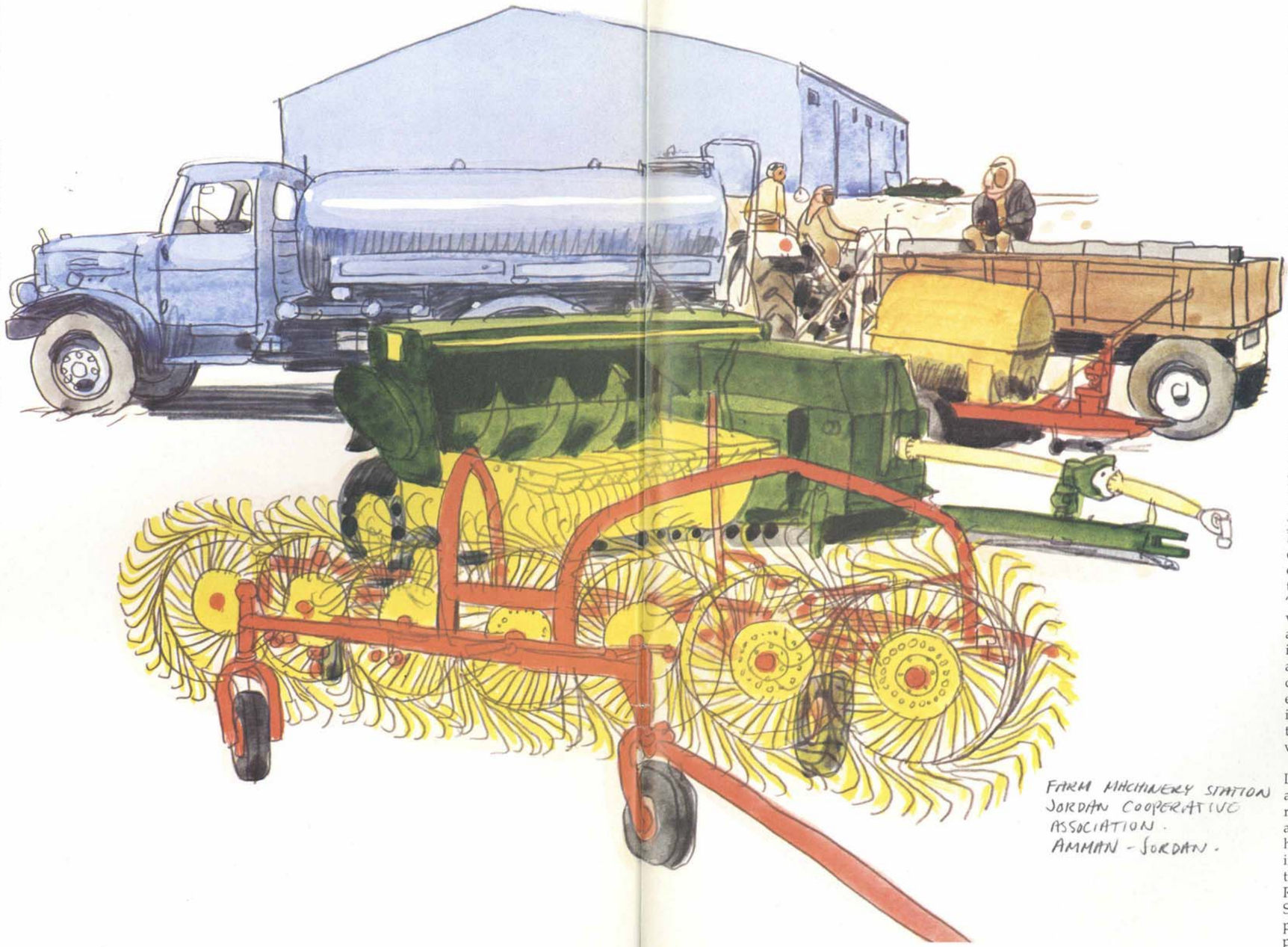
Behind this achievement is a story that in one sense began 10,000 years ago – when ancient man turned from hunting to farming near Jericho. In another sense it didn't begin until 10 years ago when the Jordanian government, a score of Arab and international lending agencies and the enterprising farmers of Jordan joined hands and money to initiate a $1-billion integrated development scheme to finally tap the promise of the past: the promise of an extensively cultivated valley, marshaling its unique agricultural resources for the benefit of the entire Middle Eastern region.

Along the way, Jordan and its partners also may have formulated a rural development strategy applicable in other countries – a strategy that has funneled a torrent of private investment into the previously neglected business of farming, relieved Jordan's chronic food imbalance, worked out an efficient working relationship between government and private agencies, and, most amazing of all, slowed and, in some cases, actually reversed the rural-to-urban migration of people that plagues most developing countries.

Officially launched by the formation of the Jordan Valley Commission (JVC) in February, 1973, the bold experiment was the culmination of both the ancient past and the more recent past: 65 years of development planning by Arab and foreign authorities.

At the time the JVC was formed, there was little to show for previous years of development. As a result of the Arab-Israeli war of 1967 and the subsequent war of attrition, the valley had shrunk considerably; its previous population of 60,000 had dwindled to a mere 5,000 war-weary farmers braving bullets and bombs to tend their citrus and banana groves and protect their precarious investments.

As early as 1913, schemes to restore the valley's ancient fertility had been routinely proposed – and routinely forgotten. One of the more important schemes, however, was put forward in the 1950s, when U.S. Ambassador Eric Johnston formulated a regional water-sharing plan to meet the needs of all the Jordan River Basin's riparian states according to international law. Though the accord has never been formally signed or ratified, its principles still unofficially guide the four states in their use of the system's waters.



FARM MACHINERY STATION
JORDAN COOPERATIVE
ASSOCIATION.
AMMAN - JORDAN.

Meanwhile, the Jordanian government had decided to study those lands and water resources that fall wholly within Jordanian territory, and at last an accurate, scientific assessment of the valley's true potential, as well as precise water projection, was made in what was called the Baker-Hazra Report.

Based on soil analysis, land classification and water measurement, the Baker-Hazra report indicated, to most people's surprise, that the valley could support considerably more cultivation, with less water, than had been assumed. Indeed, the Baker-Hazra report translated some 1913 pioneering ideas of Ottoman engineer Georges Franghia into a coherent plan.

At the heart of this plan was construction of the East Ghor Canal, which was eventually completed in 1966. Running two-thirds the length of the valley and measuring 69 kilometers (42 miles) the gravity-fed canal includes a surface irrigation network covering 11,700 hectares.

Another element in the plan was land redistribution, and in 1962, under the supervision of the newly established East Ghor Canal Authority, officials started to break up the large land holdings in favor of smaller family-owned farms, thus spreading the benefits of irrigated farming to a greater number of people. Along with the benefits of the canal, this redistribution of land was a turning point in the modern history of the Jordan Valley. It transformed the area into a high-yield source of fruits and vegetables commanding high prices in the export markets, particularly throughout the Arabian Peninsula.

By the 1960s, the first results of these efforts were being felt. New people began to settle there, schools were opened, shops were established, and roads improved. Statistical studies indicated that the East Ghor Canal had substantially increased the irrigated acreage and the total net income of the Jordan Valley. The total area under intensive irrigation had increased from 2,525 hectares (6,236 acres) in 1953 to 10,300 hectares (25,440 acres) in 1966, while the valley's net income increased more than five-fold to $5.2 million. It seemed that for the first time in some 10,000 years, the ancient soil of the Jordan Valley had started to achieve its immense potential.

Once again, however, outside factors shattered the momentum of progress. This time it was the Arab-Israeli War of 1967 which sent the pre-war population of some 60,000 fleeing from Israeli attacks, destroyed, through bombing, many of the orchards so carefully nurtured since 1960, and left the valley in a state of paralysis and fear.

Four years later, however, Jordan again realized that the valley and its untapped land and water resources could offer a significant increase in agricultural production – as well as hope for a better future. And once again, the country's planners, now working under the aegis of young Crown Prince Hassan, set out to formulate yet another – if qualitatively more ambitious – plan. Dr. Hanna Odeh, a member of that committee who has since served as president of the National Planning Council (NPC), recalls: "We had reviewed all previous plans for the valley and realized that simply increasing agricultural production and income did not in itself guarantee a rise in the social standards and general quality of life of the valley residents. We thought that a plan that covered engineering requirements was somehow insufficient. We sought more balance between technical work and the human needs of the valley."

Later that year, still another committee, addressed those specific concerns and came to realize what was involved. That committee, according to Prince Hassan, who involved himself in its work immediately after completing his studies at Oxford University, saw that the "....entire Rift Valley, from the Yarmuk River through the potash project near the Dead Sea and down to Aqaba, was ... the main productive trunk of the country in terms of planning."

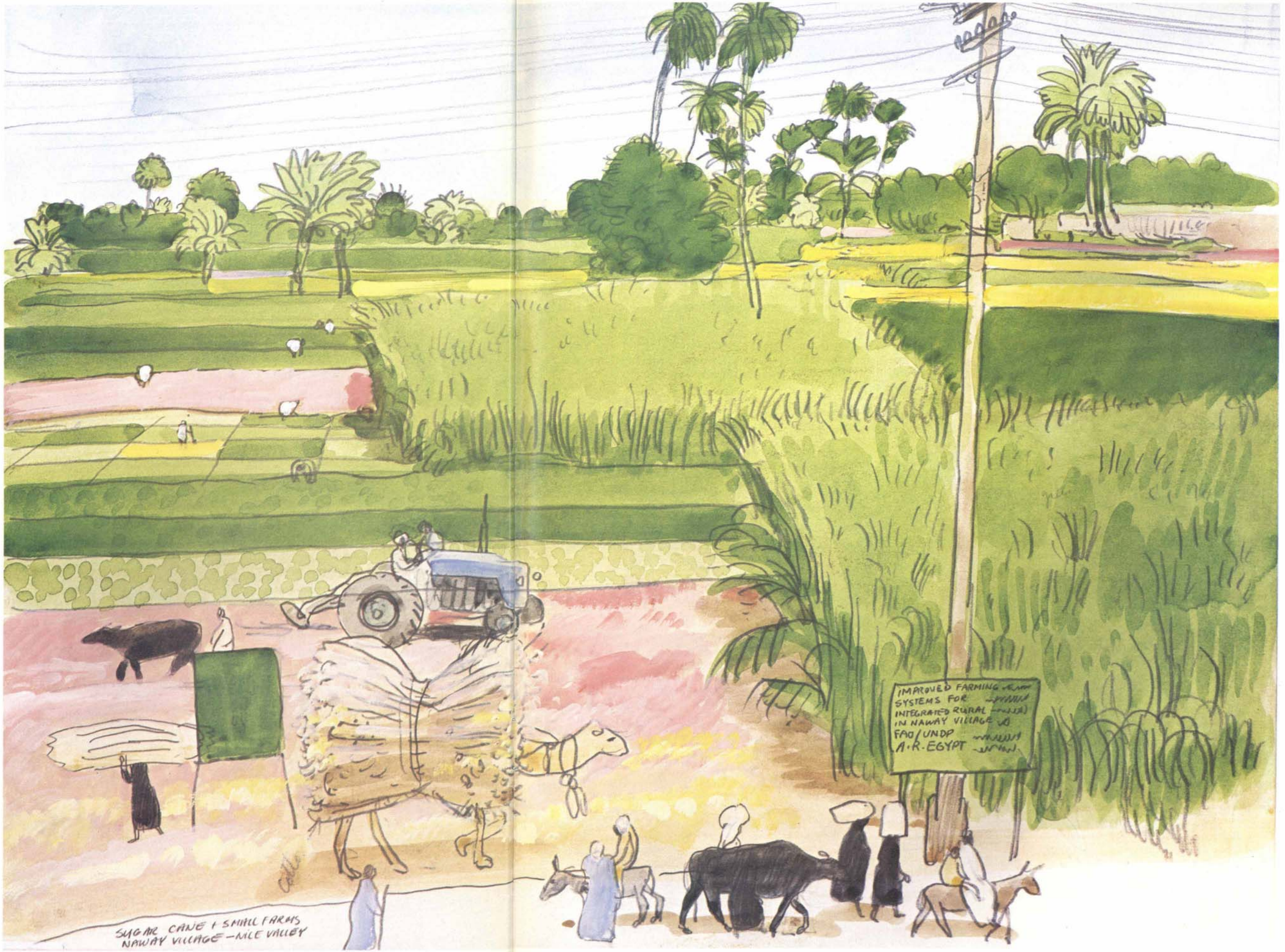
Then – in the last quarter of 1971 – the planning team made a breakthrough; they came up with the concept of "integrated development," a counterpoint to the narrow, irrigation-only focus of previous plans, and in June 1972 published its *Plans for Rehabilitation and Development of the Jordan Valley.*

A bold idea, the "integrated" plan envisaged spending $75 million over three years to rehabilitate existing irrigation works and cultivate an extra 7,600 hectares of land (18,772 acres). The plan also called for allied social services to meet the projected expansion of the valley's population from 40,000 in early 1972 to 120,000 in 1975, and 156,000 upon full development; these projects included schools, health centers, domestic water systems, roads, telecommunications, slaughter-houses, community centers and government complexes. The third element of the plan, agricultural services, included research and expansion, land improvement, marketing, forestation, agricultural credit, farm management and equipment servicing.

Finally, on February 1, 1973, after all the years of planning, Jordan established the Jordan Valley Commission (JVC), the group charged with executing the rehabilitation plan. Headed by Omar Abdullah Dokhgan, the commission was given full control over all aspects of economic life and construction activity in the valley – from licensing new buildings and overseeing land redistribution to equipping schools and medical centers and promoting such sophisticated new irrigation techniques as drip and sprinkler irrigation.

Originally, the JVC was charged with completing the main projects within three years. But the huge job proved to be too much for the small JVC staff to handle between 1973 and 1975 and by mid-1974, it was clear that none of the projects would be completed as scheduled. A new plan was drawn up, therefore, to cover the years from 1975 to 1980, this one including the great Maqarin Dam project on the Yarmuk River; a 388-million-cubic-meter-capacity earthfill dam (102.5 billion gallons), the Maqarin project will provide maximum irrigation for the valley's 36,000 hectares (88,920 acres). The Five Year Plan also envisaged new investments of $486 million, thereby transforming the JVC in one year's time into an agency handling some $600 million worth of agricultural and social service projects.

In January, 1975, the JVC awarded its first contract – to a Jordanian contractor. It covered a $6.4 million project to build the main highway running down the spine of the valley. Irrigation projects got underway a few months later, with South Korean firms winning a $5.8 million contract to install an underground pressure pipe irrigation network covering 1,500 hectares of land (3,705 acres) in the Zerqa Triangle area, where the Zerqa and Jordan rivers meet. In addition, the main East Ghor Canal was extended by another 18 kilometers (11 miles), irrigating 3,650 hectares (9,105 acres) of previously barren land in the southern part of the valley.



By mid-1975, even as the momentum of work picked up, the JVC realized once again that it had underestimated the time required, and the plan was extended yet again – into a seven-year plan for 1975-1982 – and again the goals were readjusted, this time to provide irrigation for a total of 36,000 hectares of land (88,920 acres), using underground pressure-pipe systems that could deliver the water directly to the farm – so that the farmer himself could determine how it would be applied to the land.

That decision is an example of the JVC's opposition to undue government regulations or constraints on farming decisions. Since the land is all privately owned and worked, the farmers themselves, the JVC believed, should make all decisions on what to grow, which irrigation systems to use and how to market their produce.

On October 31, 1982, the JVC – by now the powerful JVA – formally brought to a close the first decade of work on the rehabilitation plan by turning over a series of JVA projects to the appropriate ministries – having, in a sense, phased itself out of a job. Among the completed projects were 72 schools with a capacity of 27,000 students; 15 hospitals and health centers with a total built-up area of 15,000 square meters (161,400 square feet); a community development center; 13 government administrative centers; 90 kilometers of village roads (54 miles); 1,888 houses that were sold to individuals, and 350 houses for government employees; a power network serving 35 villages; three domestic water projects serving 37 villages; the 113-kilometer-long spine road running the length of the valley (67.5 miles); and 275 kilometers of farm roads (165 miles). The total cost of these village development works was $105 million, of which $39 million was financed by foreign loans.

By early 1983, the JVA had also completed the 56-million-cubic-meter-capacity (15-billion-gallons) King Talal Dam on the Zerqa River in the central valley; 62 wells scattered throughout the Rift Valley; and an 18-kilometer extension of the Zerqa Triangle Project (10.8 miles) using water from the King Talal Dam; the Hisban-Kafrein dam-and-irrigation scheme; underground drainage networks; and agricultural services that included four grading and packing centers, two tomato paste factories, a box factory, two vegetable nurseries and a soil and water laboratory. Those facilities, either completed or well underway, cost close to $30 million.

One of the exciting aspects of the Jordan Valley project is the response by private farmers and other private sectors of Jordan's economy to the government's lead. According to JVA calculations, every dollar of government money has been matched by five dollars invested by private farmers or other valley entrepreneurs. This proves, say JVA sources, that the well-honed Jordanian formula works: the government leads off and the private sector follows. JVA people say it explains the surprising success of an economy that has been declared doomed in the last 40 years more times than Jordanian planners can remember.

Another exciting aspect is the emphatically international character of the projects. Some 14 foreign governments, Arab aid funds or multi-national organizations have contributed about half the financing required and many foreign workers in search of regular income have settled in Jordan, thus becoming direct beneficiaries of the valley's development; these workers include thousands of Egyptians, Pakistanis, Indians and other nationalities. In addition to financiers and laborers, foreign countries have also fielded teams of contractors and consultants, and several Western governments have sent in experts whose tested concepts of development have been applied in the Jordan Valley.

Among the major foreign donors to the project are the Saudi Fund, the Arab Fund for Economic and Social Development, the Kuwaiti Fund for Arab Economic Development, the World Bank, the Abu Dhabi Fund, the United States Agency for International Development, the OPEC Special Fund, the International Fund for Agricultural Development, the West German, Dutch, Japanese and British governments and the EEC.

The valley rehabilitation projects have also produced important unanticipated results. Three years ago, for example, it was decided to tap the excess winter river flows of the valley and pump the water to the Amman and Irbid regions for domestic and industrial use; now, as a consequence, there's a project under construction that will pump 45 million cubic meters of water a year from the valley to the north Jordan plateau cities – 1,300 meters higher than the valley (4,260 feet), and thus requiring five massive pumping stations along the steel pipeline.

The project – to cost $225 million – should be completed by 1985, along with a similar $45-million project to tap the newly found underground waters of Mukheibeh, near the confluence of the Yarmuk and Jordan rivers, and to pump them to the Irbid region at the rate of some 60 million cubic meters per year. Linked together, these two systems will, by the end of the 1980s, form the core of a national water network and make Jordan's overall reliance on the resources of the Jordan Valley far greater than anyone could have imagined a decade ago.

Such success, oddly enough, has not ended the worries of Jordan's 8,000 farmers. Though they no longer have to worry about fertility and water, they do have other problems: increasingly stiff competition in the export markets of the Arabian Peninsula and other traditional and nearby markets such as Syria, Iraq and Lebanon, as the result of progress in those regions as well. To cope with this, valley farmers are trying to develop a more rational, coherent cropping pattern by which they can avoid over-production, low prices and gluts. Some farmers have also investigated the possibility of air-freighting produce to Europe, while others are putting their faith in the new tomato paste factories as a way of using up surpluses.

Meanwhile, the JVA has already turned its attention to another challenge: development of the country's last agricultural frontier, the Wadi Araba and the Southern Ghors in the 250-kilometer stretch from the Dead Sea to Aqaba on the Red Sea (155 miles). Already underway, this project will pose still another challenge to an economy that refuses to give in to either predictions of disaster or disaster itself, and that insists that the green revolution is here to stay.