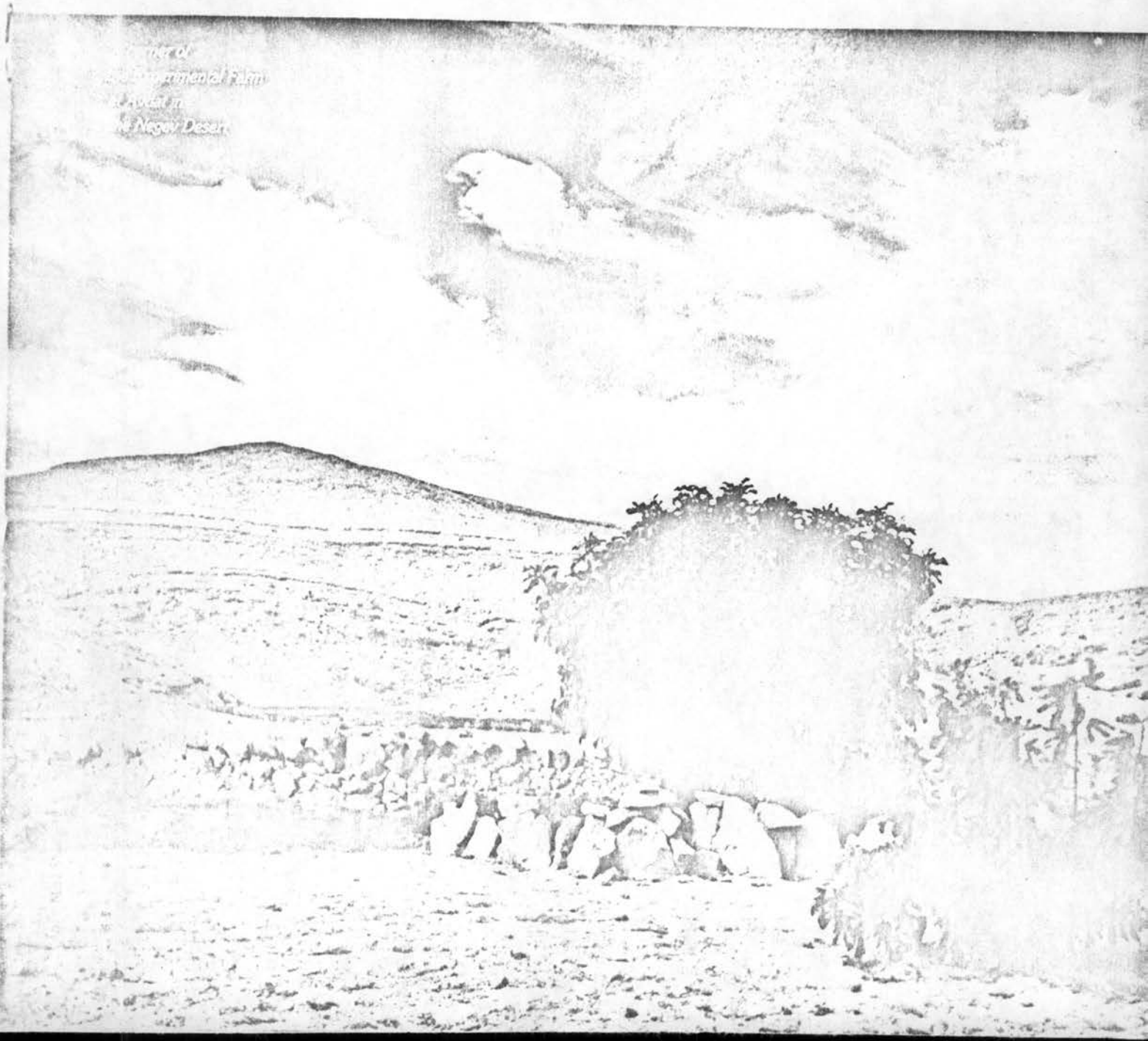
CULTIVATING FOOD, FODDER AND FIREWOOD IN THE NEGEV WITH THE AID OF WATER-HARVESTING SYSTEMS

EDITOR'S NOTE: From time to time, KIDMA readers have had an opportunity to read about one aspect or another of the important work being done at Avdat and Wadi Mashash, the experimental farms in Israel's Negev Desert. Now the Editor is happy to share with KIDMA readers an authoritative overview of the various research projects underway at the famed arid zone farm-laboratories, written by the persons directly concerned in the work.

by YEHIEL ZOHAR, HARRIE LOVENSTEIN, and JAMES ARONSON



INTRODUCTION

For nearly thirty years the Desert Run-off Farms Unit of The Ben-Gurion University of the Negev and The Hebrew University of Jerusalem has studied methods to recreate and improve the rainfall-harvesting methods developed by the ancient Israelites and continued thereafter by the Nabateans and Byzantines, at two experimental sites, (Shivta and Avdat — mean annual rainfall 80 mm), located some 70 km, respectively, southwest and south of Beersheva.

In the early 1970s a third major additional site was developed at the Wadi Mashash Farm (mean annual rainfall 115 mm), located 20 km south of Beersheva.

The Unit has already demonstrated that water-harvesting techniques can be used for the successful cultivation of a wide variety of orchard and field crops[1]. Building on our past results and experience, a major effort is now under way to develop new crops, cropping systems and applications of water-harvesting techniques, with particular stress on the needs and problems of people inhabiting the world's arid and semi-arid regions.

A well defined relationship needs to be established between the *water supply*-water-harvesting system, and the *water use*-management of various intensified agrosystems, to achieve maximal biomass production per unit of time, area and water.

WATER-HARVESTING

In the wake of the pioneering work of Evenari, Shanan and Tadmor[1] at the experimental run-off farm in Avdat, water-harvesting has been receiving renewed world attention and its very great potential in arid zone agriculture is now internationally recognised[2]. However, further research in this area is still needed.

Farming based on rainwater-harvesting is a system which allows agricultural activity in areas which normally do not receive enough rainfall, by concentrating rainfall-induced run-off water from a certain catchment area into a smaller cultivated area. The success of the system is based on three factors: *rain intensity; soil characteristics;* and *topography.* These factors are related as follows: when a certain rain intensity (mm/h) exceeds the infiltration rate of the soil (mm/h), water is not absorbed by the soil; instead it runs off along the surface to the low-lying parts in the area. A catchment area is therefore characterised by sloping surfaces with *low* infiltration rates. The cultivated area, however, often comprises a similar type of soil, and (earthen) walls need to be erected to retain the accumulated run-off water, allowing for deep infiltration. This requires deep soils with a high water-holding capacity, storing enough water to support plant production during the dry season.

Various methods have been developed to conduct the run-off water from the catchment area on to the cultivated area, including —

- *terraced wadis*, sometimes constructed with conduit channels, tapping run-off water efficiently from adjacent hill slopes;
- *diversion systems*, permitting erratic flash floods to be partly diverted to adjacent fields;
- macro-catchment basins ("limanim"), making it possible for run-off water to be collected and artificially trapped in natural depressions (0.3-0.5 ha) in the area; and
- micro-catchments, allowing run-off from a relatively small catchment area to be harvested for the support of single trees.

Jerusalem Artist Photo Archives

Early beginnings: Prof. Michael Evenari examining soil moisture under young fig tree in a micro-catchment area at the Avdat Experimental Farm back in 1971.

Research is now under way to obtain higher run-off efficiency rates by simple means, *relying entirely on local resources.* In addition, the adaptation of the different systems to various environmental and socio-economical conditions is being studied. Emphasis is put on the design of water-harvesting schemes needing a minimum of maintenance and repair.

AGROSYSTEMS

It is of the utmost importance to use the carefully collected run-off water as efficiently as possible. With this goal in mind, research is carried out, especially at the Wadi Mashash Farm, in the following areas:

PLANT INTRODUCTION

Plants, mainly native to arid lands, are screened for their potential production of food, fodder and firewood — the three most pressing needs in arid countries. Various multi-purpose trees, shrubs and annuals are grown today *entirely* under run-off conditions. The most promising ones are *Acacia salicina* and *Prosopis* spp. — firewood, leaves and pods for fodder, nitrogen-fixing; *Eucalyptus occidentalis* and *E. camaldulensis* — fast growing, firewood; *Leuceana leucocephala* — very fast growing, nitrogen-fixing, food, fodder, firewood, timber; *Atriplex barclyana* and *A. nummularia* — fast growing, fodder;

Cassia sturtii — nitrogen-fixing, fast growing, fodder; and *Phaseolus acutifolius* (tepary bean) — food. Traditional grain, oil and pulse crops, e.g. barley, sorghum, sunflower, sesame, pigeonpeas and chickpeas, are also under investigation.

CROPPING SYSTEMS

Once plant candidates are selected, they are subjected to a range of further tests. Based on the agroforestry concept, various combinations of trees, shrubs and annuals were established to assess overall biomass production in relation to water use. In mixed stands, plants *share* growth resources rather than *compete for* them, which is the case in monocultures. Deep-rooting trees exploit the deeply infiltrated run-off water, while annuals extract water from the shallow soil layers. Also, some trees tend to transpire and withdraw water in the warm, dry season, while an annual crop uses water in the cold, wet season. Thus a differentiation in time and space is achieved. Furthermore trees, because of their wind-breaking and solar radiation-intensity-reducing properties, can create favourable growth conditions for various undercrops.

For this purpose two tree types and two annual crop types are grown separately (or mixed in different densities). Through a comprehensive network of neutron access tubes, the water depletion from various soil layers can be monitored. Experiments comprising combinations of trees with shrubs have also been initiated.

For *Eucalyptus occidentalis* and *Acacia salicina* the duration of harvesting rotations is assessed; for this purpose trees are coppiced in the winter every 2, 3 and 4 years[3]. Depending on the regeneration capacity of the coppice shoots in the different treatments (including varying plant densities from 600 to 1200 trees/ha), an optimum harvesting management scheme can thus be determined[4].

Additional experiments assess the effect of initial fertiliser application during planting in an effort to boost yields; and the effect of soil tillage on crop yields. Tillage is normally employed to reduce soil evaporation and weed growth. However, due to the *high labour requirement* when tillage is performed *manually;* and the *high capital input and danger of soil compaction* when performed *mechanically;* tilling operations should be kept to a minimum.

ANIMAL STUDIES

Animals can also be integrated within certain cropping systems. As with plants, different kinds of animals are selected which are adapted to arid conditions. Promising results have been obtained with sheep, goats, and camels. Grazing trials are performed to check the fodder quality of different plants, fodder quantity uptake, timing of fodder application, and grazing conditions, in relation to food conversion rates.

With a more concentrated water supply, management practices can be more intensified, creating possibilities for the development of *sustainable* agrosystems in arid and semi-arid lands. •

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agronomist. From 1948 to 1951 he served as Director of the Southern Region at the Israeli Ministry of Agriculture, specialising in agricultural development and instruction. His subsequent services include: Director, Agricultural Planning Department, Ministry of Agriculture (1951/5); Director, National Planning Branch of the Planning Authority, Ministry of Agriculture; Director of a regional project of manpower training, Settlement and Agricultural Development in Burkino-Faso (then Upper Volta), under FAO (1962/8); Assistant Director, Rural Institutions and Services Division, FAO, Rome, responsible for programmes of regional development, rural agricultural services and institutions, and agricultural schools in Black Africa (1968/74). More recently, he has served as member of an FAO planning team for a fifteen-year agricultural programme for seven countries in West Africa; advisor (under the joint auspices of FAO and the Centre for International Agricultural Development Cooperation (CINADCO) of the Israeli Ministry of Agriculture) on the preparation and evaluation of agricultural projects in different parts of the world.
From 1978 to date, Mr. Agmon has been working as Director of the Department of Agricultural Research and Foreign Contacts in the Agricultural Centre, a settlement organisation in Israel. He has published many articles on diverse aspects of agricultural planning in different countries as well as on the activities of international agricultural organisations; and he has also participated in many national and international meetings of agricultural organisations.

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RALPH AMELAN — KIDMA's first columnist — was born in the United Kingdom where he obtained a B.A. degree in Jurisprudence from Oxford University in 1973, subsequently also receiving an M.A. degree in the same discipline from the same University. After settling in Israel, he worked for about a year in the Israel Patent Office and thereafter, as a translator for the Israel Law Review. His publications include, in addition to technical articles, contributions to the (British) Society for Interdisciplinary Studies, and a number of articles and book reviews published by The Jerusalem Post and The Israel Economist. Mr. Amelan's first column ("Law, Conservation, and Development — I") appeared in KIDMA No. 30/1984, Vol. 8, No. 2. Before that, he wrote Development and Patent Law (KIDMA No. 27/1983, Vol. 7, No. 3).

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JOHN MAURICE was born in London, England, in 1914. During the 1930s, he worked aboard ship, on the P & O line. Between 1937 and 1939, he enrolled at the David Eder Farm in the United Kingdom,

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In 1951 Maurice immigrated to Israel where the following year he joined Kibbutz Hazorea of which he has been a member ever since. Shortly after joining, he started its tree nurseries and began to pursue his life-long interest in cooperative agriculture and the Third World. He has been a consultant to DGIS, the Dutch International Technical Aid Organisation, with headquarters at The Hague. His professional interests have taken him all over the world, including Africa (Tanzania, Congo, Kenya, et al.); Asia (Peoples Republic of China, India, Nepal, Sri Lanka); and Latin America (Costa Rica, Mexico, et al.); and other parts of the world.
He started the work described in his article a generation ago, in the early 1950s. While remaining a member of Kibbutz Hazorea, he is currently conducting research at the famed experimental farm near Avdat, in the Negev.

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Dr. Schanin began his career as a teacher and youth leader in the United States. He later became Executive Director of the Brooklyn Zionist Youth Commission, Founder-Director of Camp Tel-Yehudah of Young Judaea, National Director for Young Judaea, and Educational Director of The Forest Hills Jewish Center in Queens, New York. He has lectured widely on education and frequently contributed to academic publications. He has written a textbook for children (Tefilla V'Hag La-Talmid) with workbook and teachers guide; as well as articles, curriculum outlines and guides for Jewish schools in Jerusalem and New York. He is a member of the Association for Supervision and Curriculum Development, United States; the National Council for Jewish Education; and a past-president of the Educators Assembly of the United States of America.

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