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Report on a visit to Israel August-September 1964

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REPORT ON A VISIT TO ISRAEL

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by D.J. Carder
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Service

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I wish to express my thanks to the Director of Agriculture and the Commissioner of Soil Conservation for the granting of a subsidy to the air fares and of special leave for this visit. With the assistance given it was possible to make the visit during long service leave by flying both ways between Rome and Israel, allowing three weeks in that country.

Grateful acknowledgements are due to Mr. N. Gil, Chief of the Soil Conservation Service of the Ministry of Agriculture, Israel, and his staff, present and seconded. Mr. Gil kindly granted me two interviews, at the beginning and towards the end of my visit. Among many others, special thanks are due to Mr. S. Steckelmacher of the Soil Conservation Service, Mr. I. Lanir, Co-Manager of the Shiqma Project, and Mr. Y. Ofer, range agronomist at Beer Sheba, who between them showed me over nearly the whole country and spared no effort to make my visit memorable. Their personal hospitality and that of their families far exceeded the bounds of duty.

The staff of the Agent General in London were also most courteous and helpful.

<u>ITINERARY</u>

<u>August</u>		<u>Overnight</u>
Wed. 19	Rome to Lod Airport by El Al (Israel Airline)	Tel Aviv
Thur. 20	Soil Conservation Division Head Office	"
Fri. 21	As above. Coastal plain with Mr. Steckelmacher	"
Sat. 22	Free day. Visit to Ashquelon	"
Sun. 23	West Galilee, study of uncontrolled grazing on pastures and scrub	Qiriat Tivon
Mon. 24	Jezre'el Valley and Ephraim Mts - pasture developments, with Dr. J. Katsenelson and official Turkish mission	Ramot Hashavim
Tues. 25	Southern coastal plain and Rehovot Institute with Mr. Steckelmacher	" "
Wed. 26	Sharon plain with Mr. Schneiderman	Tel Aviv
Thur. 27	Free day. Tour of Jerusalem	"
Fri. 28	Free morning. Travelled with Mr. Lanir to	Kibbutz Shaar - Ha'amakim
Sat. 29	Free day. Acre, Haifa, Megiddo	"
Sun. 30	Shiqma project with Mr. Lanir	Tel Aviv
Mon. 31	Travelling	Nazareth
<u>September</u>		
Tues. 1	Upper Galilee with Mr. Farak	Nazareth
Wed. 2	Hula Valley with Mr. Steckelmacher	Mahanayim
Thur. 3	Lower Galilee with Mr. Stechelmacher	Ramot Hashavim

Fri.	4	Head Office. Travelled to	Beer Sheba
Sat.	5	West Negev with Mr. Ofer	"
Sun.	6	Inspected experimental plantings round Beer Sheba	"
Mon.	7	Dead Sea area with Mr. Ofer	"
Tues.	8	Central Negev " " "	"
Wed.	9	Travelling	Tel Aviv
Thur.	10	Returned by air to Rome	

SUMMARY AND HIGHLIGHTS

The main features in which farming methods and the environment in Israel differ from those in Western Australia, as they appeared to me, are:-

- the dominant sedimentary and limestone geology with its accompanying soil and moisture conditions
- population pressure which puts a premium on agricultural productivity and research
- the widespread use of sprinkler irrigation

These factors interact in various ways so that, although many problems are similar in the two countries (both have many pioneering problems remaining) the approaches to them vary considerably.

Water supplies are limited in both countries and a great deal of work is being done to develop and conserve them. Due to the need in Israel to support a large population on a small area, much greater emphasis is placed on irrigation and on growing a wide range of crops. While the Sea of Galilee, it is hoped, will supply over one fifth of the total natural water resources, springs and wells drawing on underground aquifers are the most important source of water.

Thus the emphasis in dealing with run-off is on holding it in the drainage lines, sometimes to store it in dams but preferably to make it soak in to re-charge underground aquifers. The geology and the absence of highly saline ground waters favours this approach. Thus avoiding evaporation is sought at the cost of detailed surveys of geological, engineering and economic aspects.

Their Soil Conservation Service puts very little emphasis on contouring. As so much of the land is devoted to row crops and is irrigated by sprinklers in rotation, contour layouts would not allow convenient and economical management. A soil and land-use capability survey, published in 1955, covered all the agricultural areas down to and including the northern Negev. As much as possible new areas of settlement are developed in accordance with this or detailed re-surveys, and the farming of older settlements adapted to it through an extension programme.

Erosion control is dealt with in the context of the land-use classification. Land subject to erosion may therefore be classed as unsuitable for cultivated annual crops and be put down to perennial cover. The drainage lines may be controlled incidentally to water harvesting and grassed waterways first established by irrigation though they may not be watered directly thereafter. Perennial species therefore feature in many of the waterways in spite of the strictly winter-rainfall climate.

Generally speaking, a distinction is made between arable land and pasture land, and on the arable land legumes are usually grown as fodder crops. Thus it is quite unusual for a ley-crop rotation to be applied over the whole farm. Even in the Shiqma catchment project, in aid of which great interest has been taken in Australia ley-farming methods, the system is being tried in a rather specialised way on bad-land topography which is extremely difficult to cultivate (see the notes on the Shiqma "B" sub-catchment on page 16). This point on farming systems is illustrated by the land-use classification (see pages 10 and 14) and the notes on some individual settlements (page 22).

The Shiqma Watershed - Management Pilot Project is a very fine example of a detailed attack on the problems of developing sound farming systems for "new" areas with a rainfall which is unreliable and marginal for existing systems. The attack has involved detailed soil, land-capability, geological and meteoro-hydrological surveys. On the basis of these, possible systems of land-use have been planned and applied on selected representative sub-catchments. After several years the physical and economic results will be closely examined and land-use systems decided upon for wider application in the watershed and elsewhere. As it illustrates environmental conditions and farming methods in Israel and is of great interest in itself, the Project is dealt with in some detail in a following section.

Due to the pressure for productivity and the use of row cropping and irrigation, quite a lot of land grading is done (not for flood irrigation) in the course of which drainage lines are straightened or re-aligned. As a generalisation, an excavated or shaped channel was considered safe up to a grade of 6 per 1,000 (0.6%) preferably ungrassed as plant growth would restrict the flow. Drop structures (I saw these almost solely in connection with gauging stations) are in concrete and designed by engineers.

The run-off studies I saw were at two levels: rain and stream gauging on catchments of various sizes, and on a laboratory scale at the Rehovot Institute. The latter had a miniature rainfall simulator used mainly for research into increasing run-off in dry areas. Due to limited time I did not see field-plot size rainfall simulators or work on the stabilisation of coastal sand dunes.

For soil management in orchards a non-cultivation programme with a ground cover of annual species is advocated where water supply is sufficient. It is estimated that 10 to 25% extra water is needed for the ground cover with about a 15% average. The standard of water applications that I saw is about 28 inches of irrigation in an area with 20 inches of rainfall. In a citrus orchard in 18-19 inch rainfall country with a ground cover of Clare sub-clover, 32 inches of water was added. The ground cover was mown two or three times during the winter, the material growing quite tall so that the last mowing produced a dense hay on the ground. Mowing was in one direction and the remaining strips between the trees were sprayed. Summer weed growth in this orchard was negligible; elsewhere without mowing it was profuse.

The use of Sub clover, mostly Clare so far, is increasing in orchards and it is estimated to increase yields by 10% mainly by increase in the size of the fruit. More magnesium is found in the leaves whereas the content is usually low. Further notes on pasture species are given on page 21 . Present trends besides the mown ground cover, is towards very simple parallelised contour layouts with no stub rows. On steeply sloping land in a vinyard where no ground cover was possible, each row of vines was planted on a grader-built contour bank, the posts leaning slightly outwards on the convex curves and the wires lightly strained.

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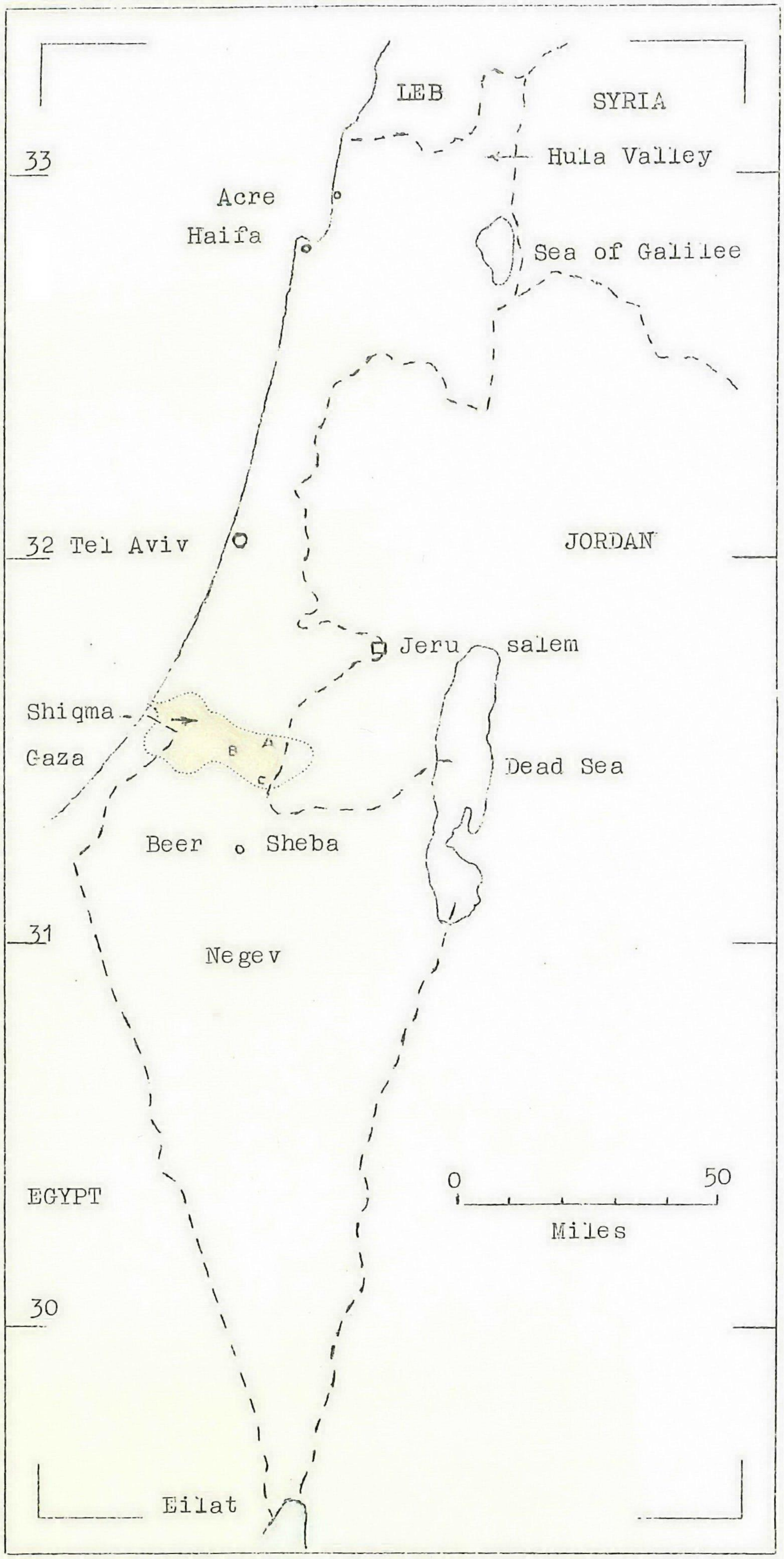


LEB
SYRIA
33
Hula Valley
Acre
Haifa
Sea of Galilee
32 Tel Aviv
JORDAN
Jeru salem
Shiqma
Gaza
A
B
C
Dead Sea
Beer Sheba
31
Negev
0
50
Miles
EGYPT
30
Eilat

The total area of the country is 8,000 square miles. Its North-south extent is 265 miles (between latitudes 33° and 29½$^{\circ}$ - compare Perth's latitude 32°, Geraldton 29°). The greatest width is 70 miles and near Tel Aviv the country is only 12 miles wide.

It has a strictly winter-rainfall climate (November to April, as it is in the northern hemisphere) and rainfall decreases southwards and eastwards.

Rainfall averages

West		East		
Acre	23 inches	Tiberias	17½ inches	(Sea of Galilee)
Tel Aviv	21 "	Jerusalem	20 "	(in the hills)
		Sedom	2 "	(Dead Sea)

South (Negev)

Beer Sheba	8 inches
Eilat	1 inch

The Negev, the southern desert, comprises about half the total area of the country.

The total population is over 2½ millions. About 10% of the population are of Arab descent, of whom about a fifth are Christian and the majority Muslim. Modern Jewish settlement started in 1881. The State of Israel was proclaimed in May 1948 and at the end of that year the population was 880,000. Thus nearly two-thirds of the population are immigrants.

Tel Aviv has a population of about 400,000; Haifa, the main port, 160,000; Jerusalem 150,000 in the Israeli sector.

The rural population is about one quarter of the total. All rural homes are grouped together in villages or settlements partly for defence and partly, in the case of the Jewish settlements, for the better assimilation of migrants and the building up of a social pattern. The settlements vary in their organisation from individual land ownership and private enterprise, through varying degrees of co-operation to completely communal economies. The latter, the Kibbutzim, are formed by voluntary groups usually with some political or religious affiliation or from a common country of origin. Kibbutz members comprise only one fifth of the rural population but their productivity and ability to assimilate migrants is proportionately high. About 500 villages or settlements have been established since the rise of the State (1948).

About three quarters (by value) of the country's food is home produced, the deficiencies being in cereals, grain fodder and fats. In 1958 industrial exports started to exceed agricultural exports.

The main products sold abroad are:-

Agricultural: citrus (86% of the total) fruit preserves and juices, eggs, edible oils and groundnuts.

Industrial: diamonds, textiles and clothing, tyres and tubes, vehicles, plywood, cement, books and craftwork

WATER SUPPLIES

Water is the only commodity rationed in Israel. A Water Commission determines yearly the allocation to each town, settlement and factory. The total water resources of the country, when fully developed, are estimated at 1.5 billion cubic metres annually, that is about 1.2 million acre feet. The estimated resources include the National Water Carrier (see below), impounded storm waters and even purified sewage effluent, but do not include any water obtained by desalinsation. Present consumption is running at 1.35 billion cubic metres, or 85% of the estimated resources if these can be developed as planned.

The main sources of water are wells, many of them located on the coastal plain. At present these are overdrawn to the extent of some 320 million cubic metres annually and the consequent lowering of the water table has been followed by invasion of sea water in places. The Water Commission also stipulates the draw on individual wells in an attempt to maintain good quality water.

No large-scale desalinisation plant is yet in operation. A U.S.A.-Israel Desalting Project hopes to produce very high quality water from sea-water at a cost of about one shilling (Australian) a cubic metre (220 gallons). The proposed plant would use the distillation method and produce ½ million cubic metres (110 million gallons) of water a day as well as 175,000 KW of electricity.

Eilat, the southern port, has much smaller plants in action. These include four units using a freezing process which have a combined capacity for over 200,000 gallons of water a day though these are not yet in full production, and a distillation unit with a capacity of 900,000 gallons a day

The national Water Carrier takes water from the Sea of Galilee to the Negev by a series of canals and tunnels and by a 9 ft. diameter pipeline. Further supplies are added from springs along its length. The Carrier as designed comprises more than one fifth of the total water resources. The main sources of water supplies for the settlements and for irrigation are this Carrier and local wells and springs.

The scheme, which cost about £45 million (Australian) was started in 1947 and completed in the first week of 1965 by the opening of a large reservoir in central Galilee. This reservoir, which has a capacity of 5 million cubic yards and covers 325 acres, was built during last summer. The southernmost reservoir is on the south boundary of the Shiqma catchment.

The volume of usable water from the scheme is closely linked with salinity problems. The run-off into the Sea of Galilee is fresh but there are mineral springs in the bed and by the shores of the lake. The under-water springs are kept partly in check by pressure of the water above so that it is considered unwise to allow the water level of the lake to fall by more than 10 feet. The available reserve in the Sea when the incoming flow from the Jordan is low due to drought is estimated at 500 million cubic metres (about 400,000 acre feet.)

Salinity figures are usually quoted in Israeli sources as milligrams of chloride per litre. The only figure I have on average composition of the salts is for water in the Carrier in 1964 - 375 m.gm/l chloride and 1,000 m.gm/l total soluble salts. (It will be noticed that this figure represents a slightly lower proportion of chloride ion than the 45.5% which is the average figure for waters in the wheatbelt of Western Australia). In the following sections, both to retain accuracy and give some convenient impression of magnitude, the source figures are quoted and then shown, in brackets, first re-calculated as grains per gallon of chloride ion and secondly by an estimate of grains per gallon of total soluble salts, using the 375 : 1000 proportion.

The supply from the Sea of Galilee has a long-term salinity of 340-350 m.gm/l Cl (about 24 g/g Cl, 70 g/g T.S.S.). The interim official standard for the tolerable upper limit of salinity has been set at 170 m.gm/l Cl (12 g/g Cl, 34 g/g T.S.S.) for areas north of Tel-Aviv and for the irrigation of oranges, and at 250 m.gm (17.5, 50 T.S.S.) for areas south of that city.

Obviously a considerable reduction of the salinity of the supply is needed to meet this standard. It is being tackled in two ways. The salty springs in and near the Sea of Galilee are being tapped and their water disposed of by an aqueduct. It is estimated that this method will reduce the salinity of the lake to 210 m.gm (15 Cl, 42.5 g/g T.S.S.) in 15 years' time. The second method is by admixing fresh water from springs and wells along the length of the Carrier and, later, from the desalinisation plants.

At present these additional fresh-water supplies are limited, though more wells are being dug, and are reducing the supply of acceptable water in the Carrier. In 1964 the Carrier supplied 120-150 million cubic metres (about 100,000 acre feet) and it is estimated that it will be necessary to add a further 150 million cubic metres a year of high quality water to it by 1971-72. This represents over 100 million gallons a day or the total proposed capacity of the desalinisation plant.

There is a threat by the bordering Arab states of Lebanon, Syria and Jordan to divert some of the springs and headwaters which feed the Sea of Galilee. If this is done, the flow into the Sea, and therefore the supply to the carrier, would be reduced by about one third and the salinity problems, of course, greatly increased. In this the "Jordan Diversion" threat it is proposed to divert some of the water to the Litani River, which already discharges more than the total water usage of Israel into the Mediterranean and is not used by Lebanon, and some to the Yarmuk River which is under the control of Jordan. There is an uncompleted American plan for harnessing the Yarmuk, for which there is already sufficient water: the excess water would return to the Jordan beyond Israeli territory.

SOIL & LAND-USE SURVEY

This survey, which was published with maps in 1955, covered some 3,700 square miles, including all the northern part of the country. The survey was squared off on an east-west line about 7 miles south of Beer Sheba and, at about 8 miles from that town, by a line running northwards to the frontier. Thus in general all the country with more than 7 inches average annual rainfall was included, or somewhat less than half of the total area of the State.

The survey included a detailed inventory of soil resources but only the total land-use figures are given overleaf.

In the classification a distinction was made between land classed for dry land farming and irrigable land and separate maps were published. Arid conditions limit the use of land which may have all other favourable conditions for cultivation. When such areas are put under irrigation, they fall into classes which permit full cultivation as low rainfall is no longer a limiting factor. On the other hand there are soil types suited to irrigation which, because of their topography or distance from sources of water are prevented from being put under irrigation. Therefore four priority classes were drawn up for the development of irrigable land.

Class			Square Miles	%
1-3	Suitable for cultivation of all crops (Class 1 needs little or no erosion control measures) Most potentially irrigable.		1,326	39
4	Suitable for orchards and perennial crops Most potentially irrigable		276	8
5	Suitable for pasture This includes 94 square miles which can be put into classes 2-4 after reclamation, and 439 square miles in the northern Negev which will fall into classes 2-4 if brought under irrigation		1,296	38
6	Suitable only for afforestation		345	10
7	Badlands and Negev sand dunes		80	2
	Coastal sand dunes		103	3
			3,426	100
	Fish ponds		13	
	Rivers, wadis, lakes, reservoirs		89	
	Built-up areas		175	
	Ruins, mounds, antiquities		10	
		Area surveyed	3,713	
	Irrigation priorities	1st	736	34
		2nd	608	28
		3rd	500	23
		4th	340	15

The land assigned top priorities for irrigation approximately equalled in area and roughly coincided in location with classes 1-4 of the dry land classification. Land assigned third and fourth priorities are not to be considered for irrigation until that with higher priority is fully developed. For low priority land available water supplies are possibly more limiting than economic factors.

In general the classification restricts the over-optimistic use of land. For example it will bar annual crops from Class 4 land and orchards from Class 5 land, but it does not prevent arable land (1 to 3) from being put down to orchards or afforestation.

The figures give gross physical area. About 10% allowance must be made in each class for roads, waterways and other losses.

THE SHIQMA WATERSHED PROJECT

This Project is a joint one between the Government of Israel and a United Nations Special Fund for which F.A.O. is the Executing Agency. The Project has two Co-Managers, Mr. Lanir (who visited W.A. in 1962) for the Government of Israel and an U.N. representative. The Project has, besides the co-managers, a permanent staff of an agronomist, an engineer, an administrator and two secretaries drawn from the Israeli Ministry of Agriculture. Assistance is given by nine government departments or agencies, such as the Soil Conservation and the Geological Services; Water Planning for Israel Company (Tahal) and an Inter-agency Board from which is drawn an executive committee.

There are occasional visits from consultants recruited by F.A.O., including Mr. R.G. Downes of Victoria. Three of them successively became F.A.O. Co-managers.

The purpose of the Project is to develop a co-ordinated plan of water conservation and land-use for the watershed of the Shiqma. Tests based on hydrologic and land-use premises are being carried out on three sub-catchments for physical and economic evaluation of the results.

The Project started in 1960 and after 5 years it was planned for an evaluation to be made and a possible future programme to be decided upon by the Government. It was hoped that any such programme will also serve, properly modified, for similar land types in Israel and elsewhere.

The Government contribution was budgetted as about £55,000 (Australian) for the first year, of which £12,000 was for salaries, (including 15% of the U.N. personnel expenditure) and £24,000 for building measuring stations and dams. For 1961-62 the budget was £A80,000 including £27,000 for stations and dams and £33,000 for land treatment.

One official report has so far been published, Progress Report No. 1 dated April 1962. 205 pp. with 15 maps and 10 diagrams. This summary is based on that Report supplemented by discussions and visits to each of the three sub-catchments with Mr. Lanir.

THE SHIQMA WATERSHED - GENERAL

Ten major ephemeral streams, of which the Shiqma is one, discharge more than 100 million cubic metres of water yearly into the Mediterranean. This represents about 10% of the present total annual water consumption of Israel. Incorporated in the Project was a groundwater recharge dam built in 1959 near the mouth of the Shiqma, of 10 million cubic metre capacity (2,250 acre feet). The estimated average annual flow is 24 million cubic metres.

The watershed lies in central-south Israel and has a total area of 303 square miles (194,000 acres). The mouth of the Shiqma is just north of the northern end of the Gaza strip and small portions of the watershed are in that Strip and, at the Eastern end, in Jordan. The net area in Israel is 256 square miles (164,000 acres). The length of the watershed is 31 miles East-West and of the longest tributary 45 miles.

The Eastern zone is a hill region ranging up to 3,000 feet the higher parts being in Jordan. Only the foothills, 1650-1000 feet lie in Israel, and they consist of semi-hard Eocene chalky limestone.

The central zone is a plateau undulating between 500 and 1,000 feet deteriorating towards the west into badlands created by back-cutting following a recent uplift. Calcareous conglomerates, sands and gravels are the parent materials of the soils.

The Western zone is the coastal plain, rising to 500 feet, of Pleistocene sandstones, loams and clays and sand dunes.

Rainfall averages vary from 12 inches, in the south and central sections, up to 16 inches near the coast, and in the northern section. Towards the east that average is fairly well maintained as the elevation increases. It is a strictly winter rainfall regime with an average of 35 rainy days. The wettest year recorded averaged 21 inches over the watershed and the driest, 5 inches. It is estimated that out of every 10 years, one is a drought and three more are very marginal. Annual potential evaporation generally exceeds $6\frac{1}{2}$ feet.

Simple rainguages were increased to 60, and 5 recording guages and complete meteorological stations for each pilot sub-catchment were installed.

Three hydrometric stations existed at the start of the Project and five more have been added. The few figures published show generally low run-off, though in one sub-catchment a 2 inch rain, which included 1 inch per hour for half an hour, produced a 15% run-off.

The average figures for the catchment (24 million cubic metres discharge from 758 square kilometres with 350 millimetres rainfall) suggest an average overall run-off of about 9%, that is about 1¼ inches.

The recharge dam at the coast is being silted up at the rate of 100,000 cubic metres a year which would give it a life of 100 years.

A geological survey was carried out and 30 boreholes drilled for underground water, giving the following conclusions.

Under the coastal plain there is a very good aquifer (Pleistocene age) covering about 152 square miles. It could yield 16,000 acre feet of water a year safely at a fast rate and with a salt content of 7 to 21 grains per gallon of chloride ion. However this aquifer is over-used for irrigation to nearly three times its safe yield so that the water table has dropped three feet below sea level. This led to the building of the dam from which water is pumped into the sand dunes to recharge the aquifer. However infiltration in the ponds fell from six feet of water a day at the beginning to 15 inches a day. This reduction is believed to be due to biological clogging of the sands. Probably microbial action on organic materials results in an accumulation of polysaccharides which block up the pore spaces. In the bottom of the dam itself, siltation reduces infiltration. It is assumed the water table will not be stabilised until the National Water Scheme is completed. The water from this area is for agricultural use on 20,000 acres (32 square miles).

In the central area there is a thin and sometimes discontinuous aquifer which should safely yield 1,200 acre feet a year at a medium rate with a salt content of up to 85 grains per gallon of chloride. It is for agricultural use on 1,100 acres under supplementary irrigation or 400 acres under full irrigation.

In the Eastern zone there is a poor aquifer in Eocene strata of unknown total yield but in which the yield is too slow for irrigation purposes. It can therefore only be used for domestic and stock supplies.

Thus in 1961 the total local resources of surface and ground water were 25,000 acre feet of which two thirds were in the coastal plain. The two main sources of supply are wells in the coastal region and the Yarkon pipeline (which will be linked with the National Water Carrier). The Yarkon is a small river near Tel-Aviv the springs of which have been tapped. The general standard of water application is 19 inches in the irrigated areas and four to eight inches for supplementary irrigation.

LAND USE IN THE SHIQMA

About 25% of the catchment is not used for agricultural purposes, (including built-up areas). The agricultural land is used as follows

Winter grains	24.5%	= 70% dry land crops
Fallow	21	
Summer grains	12	
Hay and green fodder	8.5	
Seed legumes	4	
Industrial crops	3.5	= 11% irrigated crops
Vegetables	2.5	
Hay and fodder	3	
Grains	2	
Orchards (2/3 Citrus)	3	= 3% irrigated orchards
Pasture	17	= 17% pasture
Afforestation		= 1.5% of total catchment

The land in the watershed belongs to the government and is leased to the settlements. There are 19 collective settlements (kibbutzim), 18 co-operative settlements (moshavim) and four "ranches".

Detailed soil, vegetation and land-use capability surveys were carried out. The results and classification of the latter is as follows.

1.	Very good.	Suitable for cultivation of a wide variety of crops. Requires no or very little erosion control practices.	5%
2 & 3.	Good to Medium	Suitable for cultivation of various crops. Needs immediate attention - special systems of cultivation and conservation practices	53%
4.	Marginal	Cultivation of annual crops only after major conservation and reclamation work	20%
5 & 6	Not suitable for cultivation	Pasture land or afforestation	18½%
7.	Badlands		3½%

On the coastal plain, where sandy soils and sandstone ridges are dominant, both wind and water erosion are severe.

The north and eastern part of the watershed has flat alluvial soils and clay-loams resting on limestone (rendzinas) and is slightly to moderately affected by water erosion.

The south-central area, with loess soils and "black" earths (grumosols) is severely affected by wind and water erosion and 10% of this area is badlands.

Such are the general features of the watershed. Within it **three sub-catchments** of about 2,000 acres each have been selected as representative of different conditions and problems. Possible land-use systems are being tested for their physical and economic feasibility.

A. Beef-cattle raising on rough limestone hill-country

B. Sheep and supplementary crops on badland country

C. Cropping with supplementary irrigation

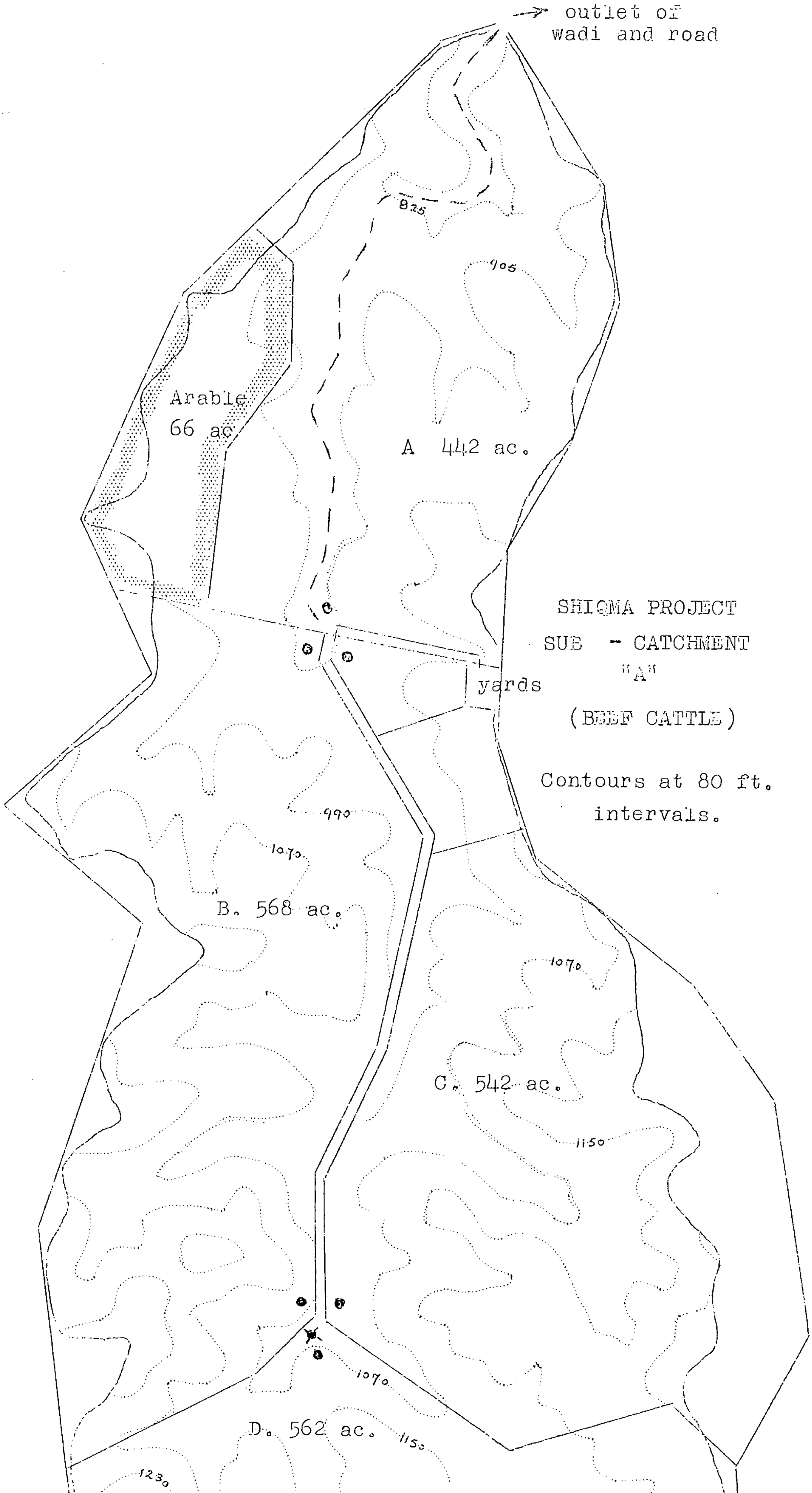
Sub-Catchment A. Beef-Cattle on the limestone hills.

This 2,250 acre area is in the north-east part of the catchment, entirely on semi-hard chalky limestone (Eocene) between 760 and 1420 feet. The hills have very shallow soils with many rocky outcrops and had a few small patches of cultivation. The main wadi and its tributaries are narrow but have flat bottoms with deep soil containing much coarse gravel and stone. There is evidence of ancient man-made terraces. The soils have a pH of 7.5 to 8.1 and have 17 to 30% lime.

The natural vegetation of annual and perennial grasses and shrubs with some carob trees was badly affected by uncontrolled grazing. Two wells and three cisterns were all unused and dry. Average rainfall is estimated at 15 inches and there is no visible run-off or erosion. This area represents 25,000 acres within the watershed and much similar country elsewhere.

The idea of afforestation was rejected as being too inflexible a form of land-use and one that was economically unjustified.

It was decided to try beef raising with 120 cows of mixed local breeds (Arabic, Turkish, Yugoslav) bred to Hereford bulls. The Project provided the basic facilities and improvements while a local settlement provided the cattle, their management (according to instructions) and records.



outlet of
wadi and road
825
905
Arable
66 ac
A 442 ac.
SHIQMA PROJECT
SUB - CATCHMENT
"A"
(BEEF CATTLE)
yards
Contours at 80 ft.
intervals.
990
1070
B. 568 ac.
1070
C. 542 ac.
1150
1070
D. 562 ac.
1150
1230

At first the carrying capacity was one breeder to 15 acres and they are in the process of doubling it on a year long basis.

Although 155 acres (8% of the total area) was considered arable, two thirds of it in the main wadi bottom, only 66 acres of the clay upland soils were set aside to supply supplementary concentrates, hay and stubble grazing. Standard provision is 250 food units per year as supplementary protein during the dry season. The breeding programme is arranged for calving to take place before the winter and weaning and removal of baby beef in Spring (end of May).

With this programme water supply is a major difficulty. Six boreholes produced one supply of 170 gallons an hour at 100 feet with 50 grains per gallon of chloride and another of 85 gallons an hour at 45 feet (15 grains). After anemometer tests, probably the only mill in Israel was installed.

<u>Sub-Catchment B. Sheep and ley farming on the Badlands</u>

This 2,000 acre badly dissected area lies in about the centre of the watershed. It is representative of about 50,000 acres in the watershed with problems of unreliable rainfall and severe erosion which would be hard to reclaim. About 750 acres of the sub-catchment was dry cropped, over 1100 acres used for uncontrolled grazing by sheep and 125 acres neglected altogether.

The established rotation is hay: winter grains: summer grains. "Hay" includes silage, field peas and fenugreek. The winter grains are wheat and barley and the summer grains sorghum and sunflower.

It was estimated (basis not stated) that to cover production costs the following yields are needed: Hay 24 cwts per acre, barley 23 bushels and wheat 16½ bushels and that such yields can be expected with 12 inches of well-distributed winter rainfall. The average rainfall is 13 inches but actual rainfall of course varies, about one year in 10 being almost a complete drought. Wheat and barley give profitable yields in about half the years but hay and summer grains are much less reliable so that cropping is marginal or distinctly unprofitable.

Three alternative proposals were considered. One, to increase the cropped area by reclaiming 900 acres, which would require severe conservation measures. This was dropped as it showed the lowest potential income and would not allow enough area for even a minimum flock of sheep. Two, conversion of all the sub-catchment into grazing land. However, it was not certain that there were suitable pasture species or reliable establishment methods. Three, a compromise between those extremes which was adopted, involved reclamation of 600 acres by simpler and cheaper conservation methods to be allied with pasture development to allow more sheep to be carried. These meat and wool-type sheep (an innovation in Israel where almost all sheep are kept for milk production) should help to smooth out the economic fluctuations of cropping and make use of unharvested crops in drought years.

Under this plan 685 acres was devoted to arable under a flexible form of the standard rotation, 1220 acres to pasture and 94 acres to be afforested.

The arable land has been treated with a small area of level banks but mostly by dozer-built check banks in the gullies at 13 feet vertical intervals or so placed that the individual catchment is less than 1 acre. Two multi-purpose dams were built to measure run-off and siltation and possibly to recharge the poor underground aquifer as well as to store stock water. One has a capacity of 20,000 cubic metres and a catchment of 895 acres of heavy alluvial soil while the other is of 35,000 cubic metre capacity with a catchment of 787 acres of light soils. Early reports were that the run-off was surprisingly little. Ground-water supplies were also small.

Besides pasture species trials, areas up to 25 acres were sown with the following mixtures (to nearest whole number in converting metric weights).

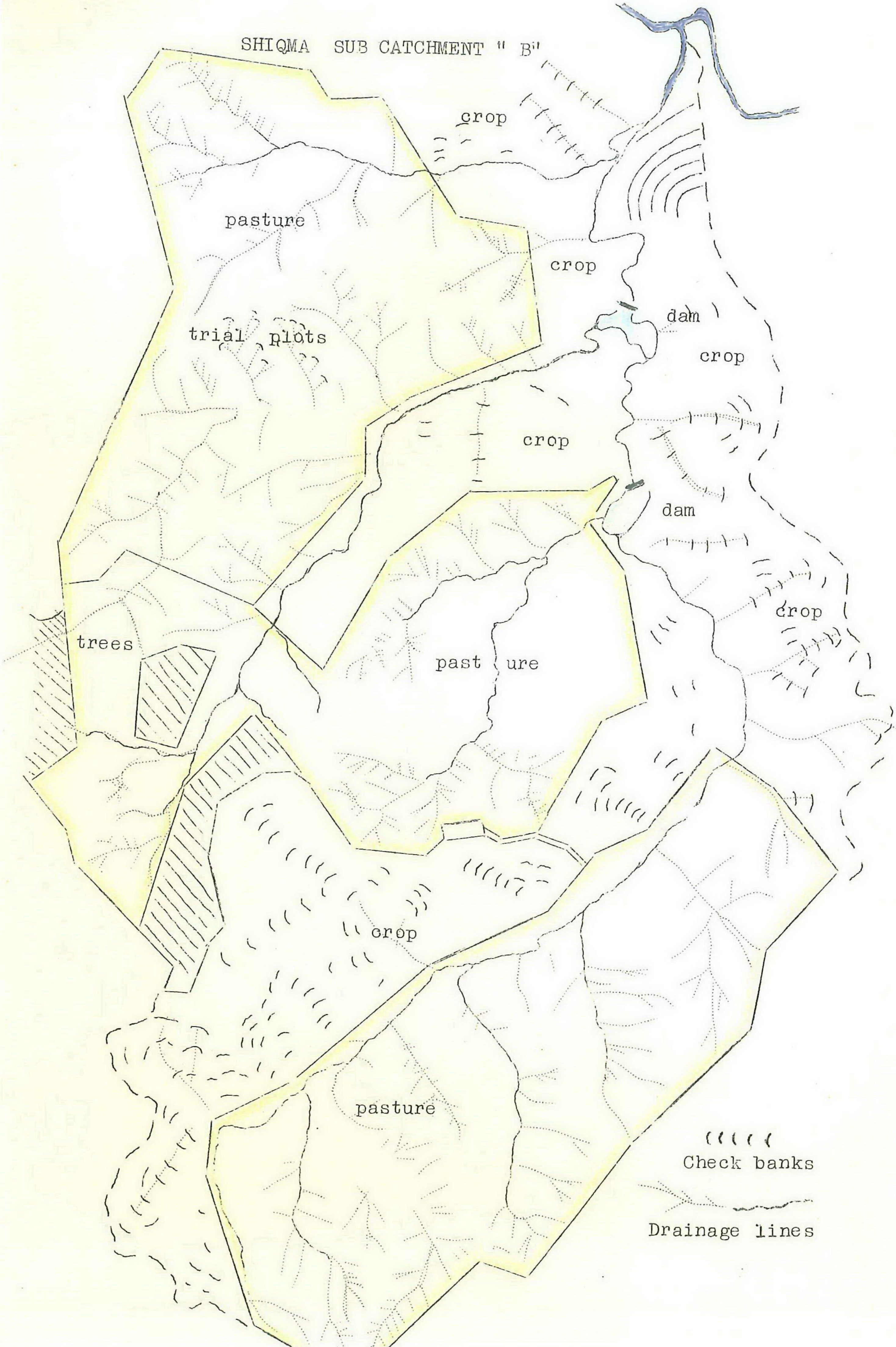
"Annuals"

(a) 2 lbs vetches, 3 lbs lucerne, 3 lbs Purple clover, on sandy loess

(b) 1 lb vetches, 1 lb lucerne, 1 lb clover, ¾ lb wild oats and Wimmera ryegrass, sown with grazing crop with super and ammonia on heavier soils

Perennials

1 lb Phalaris (Fuluja variety), 3 lbs of two varieties of Oryzopsis (Galilee Rice Grass, which has been developed locally) and stands of Phalaris and Oryzopsis separately


SHIQMA SUB CATCHMENT " B"
crop
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Check banks
Drainage lines

In the species trial there was a considerable break-through with locally bred species, especially a Barrel medic.

Saltbush was planted on 20 acres of sandy loess by machine in rows 16 feet apart with 6 feet spacing between the plants and as a fence-row planting.

The stock plan provided for a start with 300 Awassi (milk-type) ewes to be bred either to Corriedale or German Merino rams with the object of producing lambs which can be dropped in early winter and be ready for summer. The supplementary feeding plan provided for 100 lbs of cottonseed meal or its equivalent per animal to be fed over 100 days in autumn to mid-winter, plus 266 lbs of hay or straw to be fed over the last 81 of those days (3 lbs a day). This is far less than is commonly fed to milking sheep (Bedouins excepted).

Sub-Catchment C. Supplementary irrigation of crops

Work on this subcatchment was planned later than the rest and less detail is available. The average rainfall here is 14 to 15 inches with considerable fluctuations in the actual falls and the plan is to test the feasability of using run-off water on the spot for the supplementary irrigation of crops.

A gully dam was built to store run-off from a 4,200 acre catchment part of which lies in Jordan. The capacity of the dam was about 115 acre feet (140,000 cubic metres). In its first year there was no run-off but in the second, 1963-64, run-off exceeded capacity by an estimated seven times and 225 acres were irrigated.

The rotation to be tested, based on the standard wheat-fallow rotation, is winter grains to be followed by fallow or summer grains depending on the water situation. As the standard adopted allows only four to six inches of supplementary irrigation, to avoid evaporation the irrigation is done in winter. Thus there is a chance of using the capacity of the dam more than once and winter yields should be boosted as well as allowing summer crop production. Thus in the winter of 63-64, 21 inches of rainfall was supplemented by a four inch irrigation which was estimated to boost wheat yields by four bushels.

In that season, in which its capacity was greatly exceeded, 3,000 cubic metres of silt were trapped in the dam and its contour overflow was severely eroded. In the summer of 1964 the dam wall was raised by one metre and a new contour overflow was built higher up the slope. This is 2,000 feet long with a bank bine feet high and 35 feet wide across the bottom of the channel.

As it was considered unlikely that it could be grassed it was put on an 0.6% grade, the standard maximum grade for ungrassed channels.

SOIL CONSERVATION SERVICE

The Soil Conservation Service is a Department of the State Ministry of Agriculture and has as its chief Mr. N. Gil. Its functions are similar to, but rather wider than those of our Soils Division. The staff includes agronomists and engineers and there is a very efficient mapping section. This section produces attractive and high quality maps of the whole country, printed in colours and at several different scales. The whole country has been covered by aerial photography several times and it is hoped that in future it will be re-flown yearly. One of the instruments I was shown was a table sized contour stereoplotter produced by the Zeiss company of Munich and costing about $2,000 (U.S.). The Service also undertakes the design and calculations for land grading for irrigation.

The Ministry of Agriculture has adopted a policy of decentralisation and in recent years has been building up teams of advisers with skills and backgrounds suited to their regions and with a great deal of local autonomy. For example, one of the officers who took me around, Mr. Fouad Farak, a soil conservation engineer stationed at Nazareth, serves a region in Galilee where many of the farmers are of Arab descent and is himself of Christian Arab descent. The decentralisation policy has brought in its train problems of maintaining the supply of information to, and liason with the regional officers. Mr. Steckelmacher visits all the regions to help the local officers with problems and to provide liason with head office.

It has already been mentioned that the basic approach is that of land-use classification. By defining the areas and types of cultivation much of the erosion hazard is avoided. The contouring approach is not greatly favoured, both on the grounds that contouring should not be used to support an unsuitable cultivation programme and that contour systems are inconvenient where row-cropping and sprinkler irrigation are much or sometimes practiced. The contour banks systems I saw were in the rolling country of the central plain of Jezre'el. The design features were very similar to those used in Western Australia except that bank lengths were much more conservative than we have used in recent years. Variable-grade banks were used, the grades ranging from 1 to 5 per thousand (0.1 to 0.5%) with a grade of 0.5 or 0.6% at the outlet.

Contour bank systems are often made parallel because of the frequency of row cropping. Three systems of parallelisation are used. The first is by the quick pegging of contours on the ground and then adjusting them by experiment. The second is to plan the layout on paper from a map or topographic survey and then transfer to the ground by planetable survey. The third is an extension of the second by using cut and fill methods of construction.

Problems of protecting waterways from over-zealous cultivators seem to be common to both countries. Fencing off is very uncommon, in fact there are few fences in Israel though they are being used on the sub-catchments of the Shiqma project.

The photographs one occasionally sees of spectacular terracing and contour stone-heaping illustrate the work of the Jewish National Fund more usually than that of the Soil Conservation Service. The J.N.F., in relation to the Ministry of Agriculture, has a function somewhat analogous to our War Service Land Settlement scheme, allowing for the obvious differences in national and historical background.

During a brief visit to the Weizmann Institute of Science at Rehovot discussion was centred on increasing run-off for dry areas. Many rainfall events have intensities of 16 points an hour and half of the falls have an intensity under 36 points an hour. (Compare the figures for Kulin, Lake Grace, Kondinin and Dalwallinu where, in 1939-55, 52 to 60% of the total rainfall came in falls exceeding 30 points). On sandy loess soils with 9% clay the best treatment was compaction followed by a coating of black fuel oil at the rate of about a pint to the square yard. This gave 77% run-off over a 3 month rainy season and in some selected rains gave 70% run-off compared with 21% from the control. A dressing of sodium carbonate under similar circumstances gave a 66% run-off over the season and continued to work although permanent cracks in the soil opened and closed. The run-off water contained 15 grains per gallon of salts compared with 9 grains from the control. Another worker was studying in detail the effects of various mulches, including asphalts, on reducing evaporation from soil.

There was a small portable rainfall simulator in the Institute for use in the run-off experiments. It was housed in a square plastic tent into which a block of soil could be placed or which could be placed over soil in situ. Water was metered by a constant-flow pump on to an overhead tray, 20 inches square, the bottom of which was perforated by a large number of hyperdermic needles to give the raindrop effect. The metal run-off collecting trough was chisel shaped in cross-section so that it could be pressed into the soil with the minimum disturbance.

PASTURES

Considerable work is being done on improved species of both annual legumes and perennial grasses and shrubs.

Native subterranean clovers occur mainly in the north of Israel in northern Samaria and Galilee. Germination of their seed is low, down to 4% but has been increased to 50% and their seed yields increased up to 5 ounces of seed per plant in some cases. Many of the Australian selections have been tested but have generally proved inferior to local selections and crosses for local conditions, except for the variety Clare. Sub-clovers at present are used more for ground cover in orchards than for forage and seed needs are running at only about five tons a year. Nevertheless seed production methods are being studies as are the reactions of the plant with the grazing animal. Local selections have less than one per cent of the sheep infertility factors found in Yarloop in Australia. A grazing trial of Sub clover by sheep gave twice the yield of dry material than when it was merely mown. Local selections have given up to four tons of dry material per acre.

In 1964 a barrel and a burr medic (M.hispida) were most successful in the Shiqma area. Work on the traditional variety of the area, Berseem (T.alexandrinum) is still in its early stages. It is believed to contain a mixture of strains and maturities.

Work on perennial grass introductions is in the main being concentrated on four species. These include two strains of Festuca and a rust-resistant strain of Agropyron introduced from New Mexico which are being tried for special conditions. The main single criterion in their selections of Phalaris tuberosa is thickness of leaf and a recent Australian introduction is being favoured. Much attention is being given to Oryzopsis (Galilee Rice Grass).

Oryzopsis halciformis occurs from Israel northwards through Turkey to the Caspian Sea. There is tremendous variability in the material and at present selection is concentrating on early maturity. The material appeared inferior to Phalaris in the nursery plots but its field performance has been superior. This plant is sensitive to weed competition during establishment and annual weeds are kept down by cultivation or spraying during the winter before sowing. With good weed control drill widths have been reduced to 12 inches and the seed is sown late in Spring (April). By August the plants are a foot high and well tillered. In autumn (September) it is given a 2 inch watering ready for grazing and the watering may be repeated if the winter rains are late. (These details were for the north where it was growing in 19 inch rainfall country on thin rendzina soils, but Oryzopsis is being grown in the Shiqma area). After grazing throughout the winter it is spelled for seed setting and the yield often reaches 5 ounces per plant or 12 cwt. to the acre and is then followed by more grazing. The plant is palatable at all stages and is regarded as sufficient to support breeding cows at about two acres per beast even during late summer. Fat constitutes 3-4% of the dry matter. The seed is somewhat smaller than barley and quite easy to harvest.

Although saltbushes are grown as fodder plants as far north as the Jezre'el valley the main work is concentrated on them further south. Saltbush and bluebush are not grown for saltland reclamation but as low-rainfall area fodder plants. Kochia is thus being grown in an environment somewhat similar to the Nullarbor plains. A. halimus and A. lococlada are particularly promising in the area around Beersheba. The low field germination of saltbush is being offset by germinating it in the nursery and planting out the seedlings.

SOME INDIVIDUAL SETTLEMENTS

(a) SHA'AR HA'AMAKIM

Kibbutz (collective settlement)

Ten miles south-east of Haifa. About 20 inch average rainfall. Total size 1,600 acres. Established in 1934 with 100 members. It now has 300 members and 180 children up to the age of national service, and about 20 old persons, mainly members' parents. The increase in numbers has come mainly by family increase.

Of the 1,600 acres about half is irrigated and recent allocations of water have been about 19 inches an acre for 500 acres.

They have 75 acres of deciduous orchard, mainly apples and 75 acres of citrus. Other irrigated crops are potatoes, sugar beet, cotton and forage crops. Few vegetables are grown and these mainly by the children as school projects.

Wheat is grown as a dry land crop and the rotation is wheat: maize or millet: vetches for hay.

A dairy herd which totals up to 300 head of Israeli Friesian is kept. There are 115 cows and the steers are fattened. There is also a Hereford-Brahman cross beef herd totalling 450, with 200 breeders, which is kept largely on the pastures and stubbles.

Some 15-30,000 head of poultry are kept in batteries.

The soils are heavy and they have drainage problems with moisture moving through alluvial cones from the surrounding hills. They try to conserve moisture by cultivation to eliminate weeds but regard a wet winter as ending up as a dry year by making weed control very difficult.

This is a well-established kibbutz and not all the income is derived from the farm. There are industrial connections and some members work outside in the professions.

As in all settlements of this type, the farm is worked communally as a unit with modern machinery. The members, the adults, live in flats (rather like motels as the nearest Australian equivalent) and eat in a fine common dining hall in which all serve by rotation. The children sleep in dormitories and are taught in kindergartens and schools on the settlement (this is the kibbutz solution to the problem of the working mother, the married women working in some sections of the farm, in catering and in education). The school age children receive practical farm training, starting with perhaps half an hour a day in the early years and grading up to three hours farm work a day in the last year of school.

As in all settlements of this type, membership is purely voluntary and there are no State controls, apart from the allocation of water

(b) RAMOT HASHAVIM

A smallholders' settlement (moshav) about 9 miles north-east of Tel Aviv. This, the first and largest moshav, was established in 1933 by immigrants from Germany. It has about

460 inhabitants. Each member has a private home and a small family farm but produce is sold, and supplies and equipment are bought, largely through a central co-operative. Often some member of the family has an outside occupation. In appearance it resembled some of the more attractive townships in the hills above Perth.

(c) A collective-economy settlement

on the southern coastal plain in an 18 inch rainfall area. This type of settlement, called Moshav Shitufi, is based on collective economy and working of the land, as in the kibbutz, but each family lives in its own house.

This settlement has 60 families on a total area of 750 acres, of which 600 were irrigated. Land grading was in progress in developing the area for row cropping under sprinkler irrigation. The main crops were vegetables and cotton, there were 125 acres of young citrus and a dairy herd was carried. The settlement was established about 1950.

(d) MAHANAYIM

Kibbutz about 7 miles north of the Sea of Galilee and 4 miles west of the frontier. Re-established about 1954: previous settlements, of which the first was founded in 1898 had problems with their water supplies being in Arab lands.

In 1954 there were 60 members and now there are 120 with an equal number of young immigrants and probationary members.

The farm is of 1,400 acres and is mostly irrigated. Rainfall about 18 inches. Apples are the main orchard crop. Pears and peaches are also grown and there is a young citrus orchard. Cotton is the main field crop and wheat is grown.

There are two dairy herds, one with 110 cows and the other with 110 milch sheep. They also have a beef herd of 250 head and 5,000 hens are kept in batteries.

The group feels that it is not yet ready to establish an industry as it has problems of scale of operations and continuity of labour. In contrast to Sha'ar Ha'amakim, this settlement is still trying to emerge from the pioneering phase and this shows in its buildings which are of asbestos and not so attractive.