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THE AVOCADO INDUSTRY IN ISRAEL - AN OVERVIEW

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ENVIRONMENTAL GROWING CONDITIONS

Climate:

Israel is located along the southern part of the eastern coast of the Mediterranean, between latitudes 30° and 33° North.
Climate in the avocado-growing regions is subtropical: warm rainless summers and cool rainy winters. The rainy season is mainly from November through March. Annual precipitation varies from an average of 200mm in the south to 700mm in the northern coast. A major part of the avocado area in the country is along the coastal plain (see later), but notable growing area is located in the interior hot valleys. Table 1 summarizes the mean, maximum and minimum temperatures for each month in two locations: Bet Dagan, in the coastal plain, and Deganya Alef, in the hot Sea of Galilee Valley.
Temperatures below 0°C are not common in the avocado-growing areas: Orchards have been planted considering the topography, and sites with frost hazard were avoided, particularly after the mid-seventies, in accordance with a nationwide topo-climatological survey implemented by the Meteorological Service of Israel. However, temperatures in some avocado areas have dropped to - 2° - 4°C, and in some low pockets have fallen down to -7°C in certain years.

Severe damage to fruit and trees occurred under such conditions. A more serious threat to avocado crops is the adverse weather conditions which occur occasionally in April and May, a season of flowering and fruit-set: Hot spells ("Hamsins") of 40°C, and in rare cases even 46°C (accompanied by very low relative humidity), have caused severe crop failures, particularly when they lasted several days and when they occurred just after the end of bloom. This has happened on a nationwide level in 1970, 1980 and 1988.

Table 1: Mean daily maximum and minimum temperatures per month (C.) in Bet Dagan and Deganya Alef.

Month	Bet Dagan		Deganya Alef	
	Minimum	Maximum	Minimum	Maximum
January	6.6	17.9	8.4	17.6
February	6.8	19.2	8.8	19.6
March	8.6	21.5	10.4	22.5
April	11.6	24.6	13.0	26.8
May	13.6	26.7	16.3	31.7
June	17.7	29.3	16.3	34.9
July	19.3	30.6	19.0	36.0
August	19.6	30.9	22.0	36.1
September	18.1	28.0	20.6	34.6
October	14.8	26.9	17.5	30.5
November	11.2	24.2	13.7	25.0
December	8.2	19.4	9.9	19.1

Note: Bet Dagan represents the coastal plain; Deganya Alef represents the hot valley of the Sea of Galilee (Altitude 200m. below sea-level).

Soils:
Three-quarters of the total avocado areas in the country are planted on various types of Grumusols, heavy-textured soils containing 8-20% lime ($CaCO_3$), with pH 7.8 - 8.2 and with fair internal drainage. In the coastal plain, some orchards are planted on loamy sends with no lime (pH 7-7.3) or, in the south-west, with 5-10% lime.
In the Sea of Galilee Valley, some orchards are planted on very calcareous soils (40% $CaCO_3$), with trees grafted on specific adaptable rootstocks (see para. "Rootstocks").

Irrigation Water: All avocado orchards are regularly irrigated throughout the dry hot season. Most of the water in Israel is supplied by a state owned company, and allocated by the State Water Authority according to quotas linked to land tenure. Water is either pumped from underground reservoirs, containing 50-400 ppm Chlorine, or supplied from the National Water Carrier, starting at the Sea of Galilee, which contains 190-250 ppm CI. Water price is determined by the government (presently - 18 US cents per 1 m^3).

REGIONAL DISTRIBUTION OF ORCHARDS

Out of the 7,800 Ha of avocado in the country (1995), 5,600 (about 72%) are grown along the coastal plain, mostly in its northern and central parts (including 3% in the "Western Negev" in the south). Another 1,600 Ha, about 20%, are spread in the interior valleys of Huleh (in the north), Sea of Galilee and in the Valley of Jezre'el. The remaining 600 Ha, about 8%, are planted in the Southern

Lachish region and at the foothills of Judea's mountains. Orchards with high production can be found in all the above regions. However, the coastal plain north of Acco (known as "Western Galilee") was notable for years for its higher average yields, resulting probably from factors like favorable climate, suitable soils and low salinity in irrigation water. In addition, the percentage of 'Hass', the most productive CV in the country for a long period, was higher there than in other regions.

The above regional yields have dropped in recent years, partly due to increasing salinity of the local irrigation water and also due to the decrease in average yields of 'Hass', a national phenomenon which has yet to be fully explained. The aforementioned is demonstrated in table no 2.

70% of the total avocado area in the country is cultivated by Kibbutzim (cooperative settlements), 30-100 Ha each. The rest consist mainly of small family orchards of 1-3 Ha. Table no.2 represents an area of 1,500 Ha of orchards belonging to Kibbutzim. The data was provided with the courtesy of the "Miluot" regional packing house. Note: The table should not be misinterpreted: it does not represent national averages.

Table No. 2: Yields by cultivars in various periods, in the "Western Galilee" (T/Ha, rounded off)

Cultivar	Average of 10 seasons 1970/1-1980/1	Average of 4 seasons 1983/4-1986/7	Average of 6 seasons 1988/9-1993/4
Ettinger	13.0	16.5	10.5
Fuerte	8.5	12.5	7.5
Hass	15.0	15.5	8.0
Nabal	14.0	17.0	13.0

THE DEVELOPMENT OF THE INDUSTRY - A BRIEF HISTORY

The first grafted avocado trees were introduced to Israel in 1924 (to Mikveh-Israel Agricultural School). Research was initiated in the early thirties. (Introductions and observation plots). Small avocado nurseries were established in the mid-forties. Planting on a commercial scale started in the fifties and in 1960 the total avocado area reached 300 Ha. The success in the initial export of avocado on a commercial scale encouraged further planting and in 1970 the area grew to 2,100 Ha, of which 1,000 Ha were already bearing and produced 7,200 tons (of which 4,400 were exported). In the course of the next 13 years the area expanded rapidly, reaching its peak of more than 11,000 Ha (55% at bearing age). In 1983 production was almost 60,000 tons, of which 80% were exported.

The fast growth was induced by a combination of several factors, mainly:

a) High profitability in the sixties and the seventies due to adequate yields (average of 10 T/Ha), and very high export prices: 2000-2800 US$/T (adjusted to present $ value), F.O.B. Israel. Those prices were obtained in Europe owing to very intensive - and expensive - promotion activities.

b) Financial support by the government (20% allowance plus 50% loan on establishing costs) and by other national funds, for planting of export fruit crops.

c) Relatively low labor requirements compared with other fruit crops. This trait has been particularly important to kibbutzim, who tried to avoid hired labor. The sixties and the seventies were noted for the intensive research and extension activities in avocado, carried out by the Ministry of Agriculture, with very active participation by grower's organizations and individual growers.

In the early eighties, the situation changed for the worse. The following factors were responsible for this change:

1) Since 1982/83, growers experienced several successive seasons of poor return per ton, partly due to unfavorable exchange rates, particularly in the 1984/5 season. (See table no. 3).

2) The season of 1986/7, with an unprecedented bumper crop of 127,000 tons, was followed by a succession of several years with low yields. This resulted from a coincidence of extreme alternate off-season in 1987/8, followed by the disastrous 1988/9 season (85% crop failure due to a rare heat-wave), and this was followed by the severe freeze of Feb. 1989.

Disappointing production also took place in the seasons of 1992/3 and 1993/4, in which weather factors could have played a partial role.

3) The widespread planting in the late seventies and early eighties expanded to marginal climatic and soil sub-regions. In addition, resort to poor saplings, sometimes with rootstocks which were unsuitable to local soil types and salinity of irrigation water, was not uncommon at that time.

4) The gradual increase in salinity of irrigation water in considerable areas has probably caused a decrease in yields, particularly in orchards planted originally on Mexican rootstocks (which are susceptible to salinity).

5) A series of drought years brought about a reduction in quotas of water for agriculture in the early nineties, including avocado groves. Many growers cut their irrigation by 20-25% for 2-3 years until 1994,

when the quotas were increased.

Table no. 3 demonstrates the downfalls in the Israeli avocado production. Since the late eighties, erratic and low crops have shaken the dominant position of Israel as the main stable supplier of avocado to the European markets. Meanwhile, the growing demand for avocado in those markets has attracted offers by other countries. All the above problems brought new planting practically to a standstill and induced a trend of neglect and uprooting of avocado orchards. Presently, the planted area is estimated at 7,800 Ha of which 10% are new topgrafts, or new planting, which has resumed gradually in 1992, mainly by experienced growers.

CULTIVARS

In 1970, with a total avocado area of 2,100 Ha, the percentage of the main cultivars was: 'Fuerte' - 43%, 'Ettinger' - 20%, 'Hass' - 17% and 'Nabal' - 10%. This proportion was based on the accumulated experience and on the preference of the export markets at that time. The recommendations on cultivars were set by the Subtropical Fruit Governing Board and by the Extension Service. The Board has guided the research and development of the avocado industry in the country from 1960 until 1989. It included representative from research, extension services, growers and the exporting body. The above proportion of cultivars has changed considerably during the last fifteen years, and in 1995 the situation is: 'Fuerte' - 25%, 'Ettinger' - 25%, 'Hass' - 30%, 'Nabal' - 4% and 'Reed' - 6% (Estimated).

Following are some remarks on the main commercial avocado cultivars, all introduced to Israel from California, except the first one.

'Ettinger': A local selection of a chance seedling. Parentage is unknown, but it contains certain traits of the Mexican race such as tolerance to low temperatures (4 hours of -6°C in a mature tree) and thin skin. Harvest season is early but short: mainly October through November. Bright green skinned, with good commercial size. High internal quality. Yields are good to medium. A potent pollinizer to 'Hass' and 'Pinkerton' (and perhaps additional cultivars).

'Fuerte': Apparently several clones were introduced to Israel, some of them not productive. The practice of girdling, applied in some orchards (mainly in the seventies) did not solve the problem of average low and erratic yields of this cultivar. Therefore, it lost its dominance in the orchards and was uprooted or top- worked to more productive cultivars in many orchards. This trend has recently slowed down in view of encouraging results of Paclobutrazol

applications in stabilizing its yields. The main harvest season is November through February.

'Hass': The most productive commercial cultivar until 1987/8; suffered since from a downfall in average yields (see table 2), until 1995. This cultivar suffers from average small fruit size, a phenomenon which is aggravated in older plantations, due to worsening of soil aeration (increased compaction) and under conditions of increase in salinity of water. All of the above are common events in the industry. Harvest season is November through April.

'Nabal': The tree is very sensitive to winter storms (limb breakage and fruit fall), to frost, and to Pyriform Scale (see "Pests and Diseases"). Strongly alternate bearer. Average fruit-size is bigger than desired. Harvest season is mainly March and April.

'Reed': Introduced only in 1969. Precocious and productive tree. Fruits are slightly oversized. The main harvest season for export is April-May, but many growers delay harvest to the summer (June-August) for the local market.

Other cultivars grown on a commercial scale (2-3% each), are:

'Pinkerton': Mainly in the hot interior valleys. Very productive. Picked in December and January.

'Ardith' ("00-28"): Resulted from the breeding program of Dr Berg in UC Riverside. Successful mainly in the coastal plain. Very vigorous tree, relatively productive. Dark green skin. Picked in March-April.

In the older orchards there are still a very small areas of Wurtz, Benik and Horshim (a local chance seedling). Recent new plantings consist of the following cultivars, in the order of importance: 'Reed', 'Pinkerton', 'Ettinger', 'Hass' and 'Ardith'. No other cultivar resulting from the local breeding program, or from introduction, has yet reached a stage of being recommended for commercial planting; new types are tested now on a small experimental scale.

ROOTSTOCKS

In the sixties, the mother-trees for rootstock seeds were hundreds of different seedling trees, mainly of the Mexican race. In addition, seeds were obtained from cultivars: Mexican, like Topa-Topa', 'Northrop' and 'Mexicola'; Guatemalan ('Nabal') and later - West Indians or their hybrids, like 'Lula', 'Winslowson', 'Waldin', 'Fuchs'

etc. At that period, a large-scale field research on avocado rootstocks was initiated. In this unprecedented work, led by Dr A. Ben-Ya'akov, many new orchards were planted with a pre- arranged planting design of various rootstocks, without interfering with the original plan of cultivars in each orchard. A large group of avocado growers actively participated in this program; they collected yield data for every tree in their commercial orchard, which was a common practice in many orchards in the country until the mid eighties (and was aimed at thinning-out of less productive trees). The above "nationwide experiment" included hundreds of different rootstocks and gradually it grew up to 300 different plots with more than 140,000 trees. The above planting continued in the eighties and included also experiments with clonal rootstocks. Notable differences in the effects of the various seedling rootstocks (and later - of clonal rootstocks) were found, with regards to bestowing of fruitfulness, tolerance to high salinity, to high lime content and even to soil aeration. Gradually and consistently, inferior rootstocks were screened out of the list of recommended mother-trees. In the last decade, clonal (vegetative) rootstocks selected locally by Dr Ben-Ya'acov were added to the list, including 'VC 6', 'VC 51', VC 65', 'VC 66' and others. They are already demanded by growers, although still on a limited scale. Recent demands are still mainly for nursery trees grafted on selections of seeded rootstocks, primarily 'Deganya 117' and some 'Ashdot 17', both local West Indian types. In addition, rootstocks grown from seeds of certain West Indian cultivars are also in demand, like 'Waldin' and 'Fairchild'.

CULTURAL PRACTICES

Irrigation:

About 85% of the avocado area in Israel is irrigated by mini-sprinklers (with various outputs and types). In the rest, drip-irrigation is used. No obvious differences between the two methods have been found so far with regard to effect on orchard performance. However, mini-sprinklers - even under the canopy - are considered advantageous as means for partial alleviation of frost or hot-spell damages. Calculation of daily water consumption is based, in many orchards, on regional or local data on evaporation (from 'Class 'A" pan), plus orderly readings of tensiometers. The recent common practice of irrigation is not based on results from the several irrigation experiments conducted in the sixties and the seventies (with sprinkle irrigation covering most of the surface) or in the eighties (with mini-sprinklers). The typical present practice of irrigation during the peak season (July through September) for mature orchards, is the following: Intervals of 2-3 days between irrigations (with mini-sprinklers) and a dose of water calculated to

an index of 0.70 of the evaporation. This means a daily use of 5-5.5mm in the coastal plain (around 8,OOOm^3/Ha per season) and 7 mm in the interior hot valleys (around 10,000 m^3/ Ha per season).

Recent field observations on irrigation, aided by dendrometers, have not yet produced proven results which justify changes in the existing irrigation practice.

Fertilization:

Results of the several experiments in avocado fertilization, carried out in Israel, were not sufficient, so far, to serve as a general guide for recommendations. Present practices in most of the orchards are based partly on results of leaf analysis, but more on local experience and observations, on tree vigor and crop load, and on consulting with the Extension staff or with a regional researcher. The present common practice is "Fertigation" along the whole irrigation season. In some orchards, pre-bloom application of N (1/4 of the annual dose) is practiced.

A common annual dose per Ha of bearing orchards is 200-300 kg N, 50- 70kg P_2O_5 and 200-400kg K_2O. Manuring (with composts) is common in some orchards, mainly in "Bio-organic" plantations (150-200 Ha). Iron-induced chlorosis is widespread in many areas, either due to high lime content in the soil together with past use of susceptible rootstocks, or due to poor soil aeration. Fertilization with Iron Chelates is a common practice for correction.

Zinc deficiency is occasionally observed but rarely treated. Very little attention has been given so far to Boron deficiency because common visual symptoms were practically unobserved. This issue seems to deserve more attention in view of the relatively low level of Boron in many leaf analysis results.

Management of Tree Crowding (pruning, thinning etc):

The common planting density of avocado in Israel, 270-410 trees/Ha (according to cultivar and growing conditions), was planned, in the past, for future thinning- out of trees. This practice was recommended at that time particularly for 'Fuerte' and 'Nabal'; the solution suggested for problems of crowding and shade in 'Hass' was pruning. However, growers were often late with carrying out the thinning, and pruning was light or limited to some topping. The above situation has recently changed and since the end of the eighties, annual hedging and topping (mechanical or manual) became the common practice for management of tree crowding instead of thinning-out of trees.

Orchard Soil Management:

The common practice in young orchards is spraying with pre-emergence herbicides near the trees (on 1-1.5m strip) twice a year, and occasional mowing between rows. In mature orchards, the necessity of weed control greatly decreases due to shading together with the natural mulching with accumulated leaves. Pruned branches are generally shredded and serve as additional mulch.

Pollinizers and Pollinator:

In recent years, local research, supported by isozyme technique, has shown that 'Ettinger' is a potent pollinizer for 'Hass', 'Pinkerton' and perhaps additional cultivars. Application of those findings has already taken place in all new plantings as well as in many bearing orchards where 'Hass' was planted in solid blocks (by top-working 10-15% of the trees to 'Ettinger').

There are still no clear answers regarding the need for cross-pollination of 'Ettinger', 'Fuerte' and 'Reed'. Honey- bees are the main pollinator of avocado in Israel and most growers rent bee-hives for this purpose (around 2-3 per Ha).

PESTS AND DISEASES

Avocado in Israel is not greatly troubled by pests, probably due to several factors:

a) careful conservation of natural biological balance, owing to intensive research and extension, and strict practices of biological control.

b) Being a relatively new crop in a country remote from the centers of origin.

c) Strict quarantine measures taken during introduction of avocado propagation material, and ban on import of avocado fruits.

d) Events of extreme high and low temperatures that may have hindered the development of some avocado pests prevalent in the tropics.

The important avocado pests in Israel are:

Boarmia setenaria: A looper that feeds on fruitlets and fruits, which may cause considerable reduction in yield and damage to fruits if not monitored and controlled in time (by 1-2 sprays with *Bacillus thuringiensis).* The Pyriform scale *(Protopulvinaria pyriformis)* severely attacks 'Nabal', and has been observed on other cultivars. Control measures are generally spot- sprays with mineral oil, combined with spreading of wasps of the genus *Metaphycus* or of *Cryptolemus montrouzieri.*

The Greenhouse Thrips *(Heliothrips haemorrhoidalis)* may sporadically attack various cultivars. ('Ardith' is particularly susceptible).

The climate in Israel is unfavorable to development of diseases of fruit or canopy of avocado. Avocado Root-rot *(Phytophthora cinnamomi)* was first identified in Israel in 1982. It's spread has been limited, so far, to 40-50 Hectares only, mainly in moist spots of very heavy soils or other sites with poor drainage. Selection of local resistant or tolerant rootstocks is being carried out. Inflorescence Dieback may cause serious damage, in some years, mainly in 'Hass', by considerable reduction of yields of infected trees. The factor responsible for this phenomenon is still unknown.

HARVESTING AND PACKING

Harvesting of avocado in Israel is controlled by the national Avocado Corporation. Nine regional packing houses serve the industry: Two principal ones (20-30% of the total, each), four medium sized (8-10% each) and three small ones (3-4% each). National export standards for fruit maturity and external quality, which are more severe than the EEC standards, are set by a statutory committee, and inspected by the Inspection Service for Agricultural Produce for Export, Ministry of Agriculture.

Detailed crop estimates, by cultivars and regions, are carried out by the Avocado Corporation and a tentative weekly harvest program is formulated for the whole season.

This is planned together with AGREXCO Ltd., the sole exporter - by state law - of avocado and of many other agricultural products.

At the beginning of the season (generally in the last week of September) harvest starts in each region according to criteria of percentage of dry matter (representing oil content) for each cultivar. The above is determined after a repeated systematic sampling survey. Later, harvest continues according to a re-planned weekly program and allocation of quotas by the Corporation headquarters to each packing house. This is based on combined considerations of market demands, size of stocks, availability of produce from each location etc. Selective harvesting (by size) is common. Hundreds of Hydraulic Ladders ("Cherry Pickers"), produced in Israel, are used for picking in tall trees, up to 6.5m.

All exportable avocados are packed in 4kg cartons and exported (Shipped by sea).

Average export percentage for the whole registered crop has been

around 70% in recent years. Almost all the rest is sold fresh in the local market by the Corporation. Rejects and fruits for industry rarely exceed 1-2% of the crop.

PRODUCTION, EXPORT AND PRICES

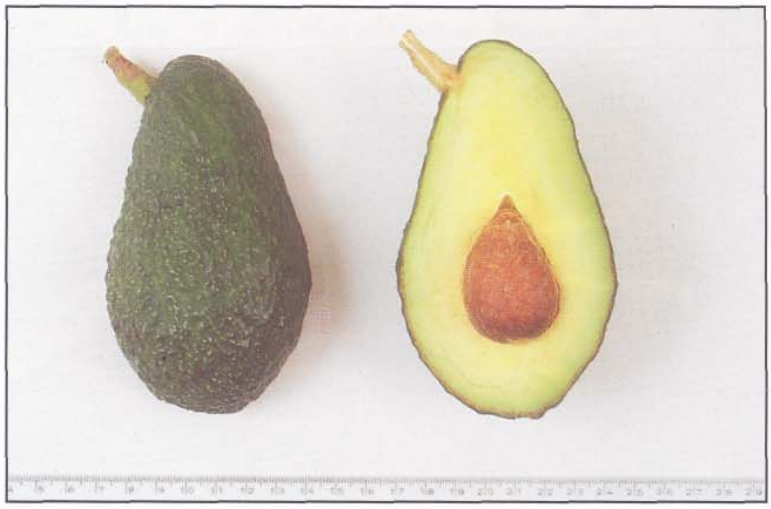
Table 3: Israeli avocado - production and export (in 1,000 tons, rounded off)

Season	Production	Export	F.O.B. Price/T, US$
1979/80	32	26	1,630
1980/81	8[a]	7	2,200
1981/82	40	33	1,400
1982/83	59	49	960
1983/84	52	43	970
1984/85	75	60	760b
1985/86	65	52	1,030
1986/87	127	88	930
1987/88	33	26	1,480
1988/89	17[a]	12	1,840
1989/90	46	35	1,350
1990/91	53	38	1,410
1991/92	74	50	1,160
1992/93	38[c]	27	1,200
1993/94	43[c]	29	1,250
1994/95	51[c]	36	1,230
1995/96 (est.)	80	60	

a= Rare extreme heat-wave in May destroyed most of the crop.
b= Unfavorable exchange-rate for the dollar.
c= Estimated 10% should be added in view of increased non-registered commerce since 1992/3.
Source: Fruit Marketing Board, and the Avocado Corporation.

Table no. 3 presents data on yearly national avocado registered production, exports, and average F.O.B. seasonal average prices, for the last sixteen seasons (each running, practically, from September through May). Unregistered local marketing of avocado has grown in recent years, perhaps due to increasing demand and other reasons. It is estimated that, on this account, 10% should be added to each of the registered crops of the last three years. Therefore, the actual 1994/5 crop, for example, was 56,000 tons (and not as it appears in the table).

The main countries of destination for export of avocado from Israel have been France (50%-60%), Germany (15%) and Great Britain (10%).



'עדי'
'Adi'

'גיל'
'Gil'

'עירית'
'Irit'

MAIN PRESENT PRODUCTION PROBLEMS

1) Average national yield/Ha: This yield has been 7.5 tons for the last six years (including 1995/6 estimate) and can be considered fair when compared to the same averages for California or Spain (particularly in view of the considerable percentage of a poor bearer like 'Fuerte'). Nevertheless, this yield is insufficient for the Israeli producer under the present costs of production and packing, and in view of the avocado trade situation. This insufficiency could even increase in the future. It has been found that considerable differences in yields per Ha exist between orchards with the same cultivar in the same region. This could only be explained by large differences in the level of orchard management, and can demonstrate the unexploited potential of production in the existing avocado area. There is therefore a need for intensifying extension activities, aimed at raising the professional and managerial levels of growers.

An additional reason for the insufficient yields/Ha seems to be the following: Flowering and fruit-set of the main commercial cultivars take place in February - May, a season of very unstable weather with temperatures too high and/or too low for optimal pollination and fruit-set. Major damage to avocado crop has been caused almost always by extreme heat-waves shortly after fruit-set. In addition, there is often very marked reduction in bee activity (pollination) in avocado orchards during the main bloom season of the major cultivars, which coincide with the flowering of very strong competitors, like the vast areas of citrus and of wild vegetation.

In the author's opinion, research, aimed at delaying the bloom of the major cultivars by 2-4 weeks, is required. Bloom should be shifted to a period more favorable for pollination and fruit-set, with stable weather, as well as termination of flowering of competitive plants.

2) Increasing salinity: The salinity of irrigation ground water in major avocado producing regions is gradually increasing, and could be responsible, at least partially, for decreased yields in those areas, particularly where orchards were planted on Mexican rootstocks. Intensifying the research on clonal rootstocks in order to maximize production under conditions of saline water, seems to be needed in order to confront future hazards in this regard.

3) Scarcity of water: Increasing prices and the scarcity of irrigation water may create, in the future, a major constraint to the whole industry. This issue can be identified, perhaps, as the most crucial production problem in the long run.

4) 'Hass': This is the most important cultivar, but it exhibits serious disadvantages like the unexplained reduction in its yields in recent years (excluding 1995/6) or the average fruit- size, which is smaller

than demanded by the trade. It is difficult to forecast whether the intensive (and expensive) breeding program, carried out in Israel for the last two decades, will ever come up with a new cultivar which will be an exact substitute for 'Hass' (or for any other existing cultivar). Nevertheless, the search for new cultivars has to become a permanent project.

Introduction and evaluation of types resulting from foreign breeding programs, have already fruited a commercial cultivar in Israel ('Ardith'), and this activity should also continue, in the authors' opinion.

ECONOMICAL ASPECTS

Economical analysis of the avocado industry in Israel involves many variables which place constrains on simplifying this intricate field. The following information will help, however, in pinpointing the main factors effecting the economical success of the Israeli avocado industry (not including, of course, trade factors, which are not discussed in this article).

1) The average yield of well-cared orchards in the coastal plain has been 10 tons/Ha for a period of 25 years (1961- 1986). At that period, outstanding orchards produced the following average yields: 'Fuerte[1] - 12 T/Ha, 'Ettinger' and 'Nabal[1] - 18 T/Ha, 'Hass' - 20 T/Ha. This may demonstrate the potential which was not realized in larger areas due to complex reasons partly discussed in previous paragraphs.

2) The cost of establishing an avocado orchard in Israel is calculated at 15,000 US$/Ha, not including the cost of land.

3) The cost of hired labor in agriculture has been recently 3-5 US$ per hour.

4) The average cost of irrigation water is 18 US cents/1m^3 (1995).

5) The calculated variable costs of production per 1 Ha of avocado in Israel, including 'Ettinger', 'Hass' and 'Reed' in equal parts, are the following: 8,850 US$ at the exit of the packing house, with a calculated yield of 12.3 Ton/Ha. Net grower's profit is 2,850 US$/H. (Source: Division of Agricultural Economics, Extension Service, November 1994).

RESEARCH AND EXTENSION

The Israeli avocado industry has been characterized since its inception by close contacts and rapid flow of information between the Extension Service, the Agricultural Research Organization (the Volcani Center), the Faculty of Agriculture in Rehovot - and the

growers. The first two bodies are a part of the Ministry of Agriculture. In 1995 the Ministry contributed 300,000 US$ to research in avocado, in addition to partially covering infrastructure costs and salaries. The Avocado Growers Corporation invested 200,000 US$ plus an additional contribution of 50,000 US$ by regional organizations of growers.

Main topics of research in avocado are:

1) Breeding of improved and more productive cultivars.
2) Selection of better rootstocks.
3) Improving production by plant growth regulators.
4) Pollination, pollinators and pollinizers.
5) Combination of irrigation and fertilization ("Fertigation").
6) Post-harvest physiology, pathology and technology.
7) Biological pest control.

The Extension staff is comprised of a team of 9 regional Extension Agents specializing in subtropical fruit crops and guided by a nationwide professional coordinator. In addition to their extension activities, they are involved in field experiments and contribute to the inventory of knowledge in avocado production. They are assisted by other extensionists who cover other domains like plant protection, "field service" (i.e.: irrigation and fertilization of crops), agricultural machinery, agricultural economics etc. Those other extension agents are located in the same region or operate on a national level.